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DIVERSION OF COTTON AND COTTON PRODUCTS FROM THEIR NORMAL CHANNELS OF TRADE 1/

By

Lawrence Myers
E. H. Omohundro
and
N. B. Salant

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I

NEW USES FOR COTTON

This represents a revision of the 23 page summary, MS-41 issued in February 1938, which lists and gives a brief review of the cotton diversion programs carried on by the Marketing Section of the Agricultural Adjustment Administration to the end of 1937. Developments since that time in this program to increase the consumption of cotton through new outlets have been sufficiently extensive to necessitate a more detailed discussion of new cotton uses to date.

Projects utilizing cotton and cotton products authorized under provisions of the Department's cotton diversion programs are listed in this publication and methods of application and results reported by cooperating agencies are discussed.

Studies of the utilization of cotton and cotton products have been carried on by the Department of Agriculture for many years. The present cotton diversion programs are made possible by recent agricultural legislation, particularly Section 32 of Public Act No. 320, passed in August 1935 and subsequently amended. Under this legislation, funds have been made available for diverting cotton and manufactured cotton products, as well as other farm commodities and their products from their normal channels of trade.

Under the cotton diversion program, looking toward the development of new uses, cotton and cotton products are supplied to cooperating agencies in consideration of their agreeing to utilize the materials for the purpose authorized, to keep records, and to submit reports with respect to the utility of cotton and cotton products for the purposes for which they are supplied. Where preliminary results show that a particular new use has promise, larger projects may be developed for its effective demonstration or exploitation. In cases where preliminary research or trial has not been made, it is desirable, for purposes of economy, first to undertake some small projects.

Cotton and cotton products have been supplied for a number of uses among which are included:

Use	Discussed on pages
1. Cotton for houses and other structures	1 to 21
2. Cotton for bale covering	22 to 34
3. Cotton for ditches and canal linings	35 to 53
4. Cotton for stabilizing road cuts and fills	54 to 62

Use	Discussed on pages
5. Cotton for roads, streets, and airport runways	63 to 80
6. Cotton for shading or protecting tree seedlings	81 to 91
7. Cotton for protecting fruits and vegetables	92 to 103
8. Cotton for use in fumigating tobacco plants	104 to 113
9. Cotton bags for peanuts	114 to 118
10. Cotton for insulating and covering beehives	119 to 121
11. Purposes for which cotton may be supplied	122 to 124

In these efforts to broaden the market for cotton, those agencies which have tried cotton material for use in connection with the above purposes have been most helpful but the number of individuals who have cooperated is so large that it is impracticable to list their names. In the development of programs, and in the development of specifications for materials, the Cotton Division of the Bureau of Agricultural Economics, particularly Mr. R. J. Cheatham, has given very valuable cooperation.

The following tabulation is a summary of the quantities of materials and the purposes for which cotton and cotton products have been supplied.

Purposes	Approximate quantity of material (Equivalent Square Yards)
In 1936:	
Reinforcing membrane for bituminous surfaced highways	6,106,566
Curing concrete in highway work, (mats made with raw cotton filling and cotton fabric covering) (number)	89,500 mats
From April through June, 1937:	
Linings for terrace ditches (laboratory experiment)	2,060
Temporary fixation of soil on cuts and fills of roads	14,430
Protective covering during curing of peaches	23,100
Covering for retention of benzol gases in the fumigation of tobacco seed beds to control blue mold	2,000
Roof and sidewall material for buildings	3,000

Purposes	Approximate quantity of material (Equivalent Square Yards)
From April through June, 1937 (continued):	
Shading tree seedlings in nursery beds	6,549
Reinforcing membrane for airport runways	20,600
Total equivalent square yards, April through June, 1937	71,739
From August 1937 to June 30, 1938:	
Reforcing material for lining of irrigation, drainage, run-off, and other types of ditches and canals	100,970
Control of erosion in connection with work on levees and revetments	2,049
Covering or membrane by itself or with other materials in the construction, maintenance, or protection of dams, reservoirs and water storage facilities and inlets thereof or outlets therefrom	17,781
Temporary fixation of soil on cuts and fills of roads	166,515
Reinforcing material for surfacing airport runways, roads, bridges, paths, and walks	310,316
As a protection for fruits, vegetables or other agricultural or horticultural products during ripening, harvesting, curing, packing, storing, or other processes	12,616
Shading or protecting tree seedlings, shrubs, trees, vegetables, plants, flowers, or other agricultural or horticultural products	510,413
Covering for retention of benzol gases in the fumigation of tobacco seed beds to control blue mold	7,071
Covering or other parts of cages or enclosures for propagation of insect parasites	214

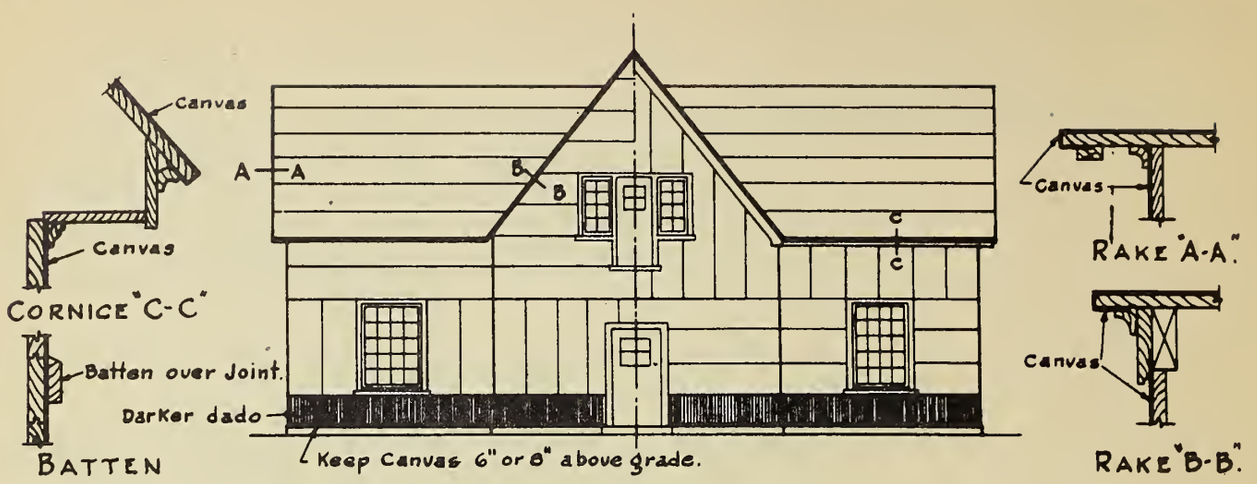
Purposes	Approximate quantity of material (Equivalent Square Yards)
From August 1937 to June 30, 1938 (cont'd.):	
Covering to prevent egress of pests which might cause infestations	70
As protection for colonies or hives of bees	117
As roofing, outside covering material, insulation, or other integral parts of houses, cabins, cottages, or other permanent or semi-permanent structures	18,456
As covering for bales of cotton	209,005
As bag or covering for agricultural or horticultural products, where not now normally or commercially used	199,650
Total equivalent square yards, August 1937 to June 30, 1938	1,555,243
From July 1, 1938, through January 7, 1939:	
Roof, sidewall, and insulation material for buildings	179,897
As bag or covering for agricultural or horticultural products, where not now normally or commercially used	282,687
Reinforcing material for surfacing streets	41,391
Shading or protecting tree seedlings	130,300
As covering or pattern for bales of cotton	91,070
Temporary fixation of soil on cuts and fills of roads	36,666
Construction of dams and reservoirs	4,600
Total equivalent square yards, July 1, 1938 through January 7, 1939	766,611

HOUSES AND OTHER STRUCTURES

The long-known durability of cotton duck for battle ship decks has suggested the use of this and other cotton materials for roofs and side walls of buildings. Similarly, the low thermal conductivity of cotton has given rise to its use as an insulating material.

Photographs 1 to 7 picture a few of the projects on which cotton is being used.

Sketch 1



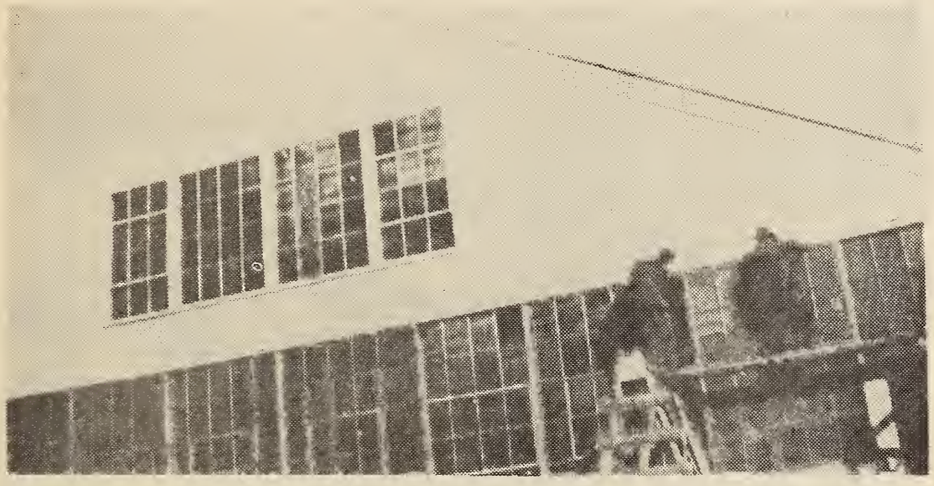
Combined horizontal and vertical strips of canvas for architectural effect (Sketch 1)

Photograph 1

Woodworking ship, Sublimity Service Area, London, Kentucky., showing horizontal canvas strips with wood battens at joints. (Photograph 1).

Sketch 1 shows how cotton fabric can be used on side walls and roofs to secure architectural effect; and photograph 1 shows the use of cotton fabric as side wall and roof material, in a wood-working shop, near London, Kentucky.

Photograph 2



Photograph courtesy of the company which manufactured the cotton fabric.

View of repair shop at Salem, Virginia, (photograph 2), showing cotton fabric being used as a side wall material in the gable ends. The smooth neat appearance of the material is easily discernible.

Photograph 3

Photograph by Department of Agriculture.

Perspective view showing how the repair shop at Elkins, West Virginia, looks when completed, (photograph 3). The side wall material is cotton fabric white in color; the roof, of cotton fabric of dark grey color. Many colors of cotton fabric are obtainable to suit the particular requirements (see page 8).

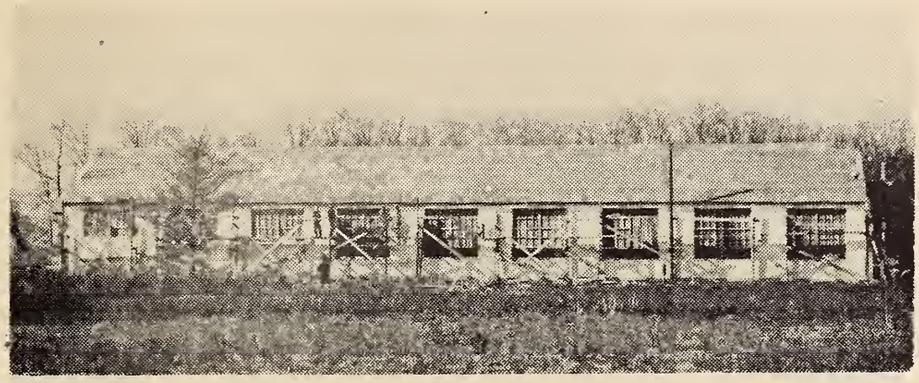
Photograph 4

Photograph courtesy of the company which manufactured the cotton fabric.

View of service building at Salem, Virginia, (photograph 4). In the background, the application of the cotton roof over sheathing can be seen.

For either side wall or roofing the cotton fabric can be equally as well applied over plywood or composition boards.

Photograph 5



Photograph by United States Department of Agriculture.

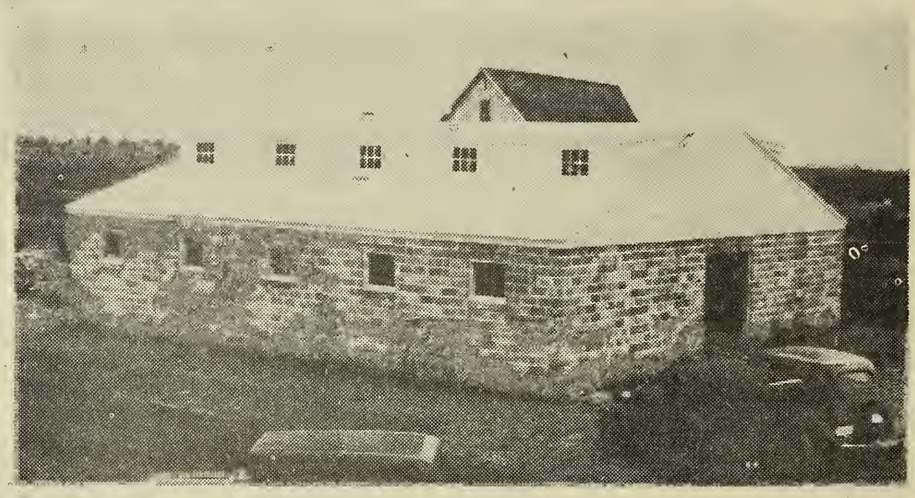
Central repair shop, Elkins, West Virginia, (photograph 5). Another illustration of the effective use of cotton fabric as a roofing and side wall material.

Photograph 6

Photograph by United States Department of Agriculture.

Foreman's residence near Ames, Iowa, for Soil Conservation Service (photograph 6). Designed by W. Ellis Groben, Consulting Architect, United States Department of Agriculture. Cotton fabric used on entire roof. Cotton fabric was also used on the side wall and ceiling of two small porches which are not shown in the photograph.

Photograph 7



Photograph by United States Department of Agriculture.

Storage house near Ames Iowa, built for the Soil Conservation Service, (photograph 7). Designed by W. Ellis Groben, Consulting Architect, United States Department of Agriculture. A further illustration of the use of cotton fabric as a roofing material for agricultural and industrial buildings.

Specifications of Fabrics:

Federal specifications of unbleached cotton duck are shown in Table 1.

Table 1. - Federal Specifications of Unbleached Cotton Duck

Number	Minimum Specifications						
	Weight per square yard 1/	Ply of Yarn		Thread Count		Breaking Strength	
		Warp	Filling	Warp	Filling	Warp	Filling
	ounces			number	number	pounds	pounds
Hard Texture 2/							
2	27.12	5	5	25	19	420	345
4	23.93	4	4	27	20	375	300
6	20.74	3	3	32	24	335	250
8	17.55	3	3	31	21	285	210
10	14.35	3	3	42	24	245	160
Medium Texture 2/							
2	27.12	5	5	24	14	410	320
4	23.93	4	4	26	17	350	290
6	20.74	3	3	32	18	305	250

Note: Commercial length of duck rolls is 110 yards; width in inches 26, 28, 30, 32, 36, 38, 40, 42, 44, 48, 50, 54, 60, 66, 72, 76, 84, 90, 96, 100, 108, 120, 132, and 144. However, widths of 72 inches or less are more readily obtainable than wider widths.

1/ After being fire-resistant treated, duck is about 50 percent heavier.

2/ Medium texture duck takes fire-resistant treatment a little more readily than hard texture duck.

Specifications for fire-resistant cotton fabric:

Fire-resistant treated cotton duck supplied to date under the program is reported to have the following characteristics. It will not flame for more than two seconds after the test flame is removed and an average char of 10 specimens does not exceed 2-1/2 inches with a maximum char of any one of the 10 specimens not more than 4-1/2 inches when tested by the following method:

Method:

Ten specimens of fire-resistant treated cotton fabric 2 x 12 inches are cut with their long dimensions in the direction of the warp and 10 in the direction of the filling. The specimens of fire-resistant treated cotton duck are suspended vertically from a clamp covering the upper 1/2 inch of the length to protect specimens from drafts. The apparatus used to test the fabric is enclosed in a sheet metal shield 12 inches wide, 12 inches deep, and 30 inches high, open at the top, and provided with a vertical sliding glass front. Sufficient room is left at the bottom and the front to allow manipulation of the gas burner used in igniting the specimen. The specimen of fire-resistant treated cotton duck is suspended with its lower end 3/4 inch above the top of a Bunsen or Turrell gas burner, with a tube of 3/8 inch inside diameter, and with the air supply completely shut off is adjusted to give a luminous flame 1-1/2 inches long. The flame is applied vertically near the middle of the width of the lower end of the specimen for 12 seconds, then withdrawn, and the duration of the flaming in the specimen noted.

In addition the fire-resistant must not be leached out after being exposed to the weather for 2 years or more.

Federal specifications which fire-resistant treated cotton fabric would be required to meet, on a physical basis, are now being prepared.

Colors of fire-resistant cotton fabric:

Fire-resistant treated cotton duck is available in a wide variety of colors. Among the colors in which ducks can be secured are:

Brown
Black
White
Olive Drab
Khaki
Orange
Aluminum
Green
Terra Cotta.
Dark Grey.

Types of material most suitable and method of application:

Definite instructions as to method of applying cotton and cotton fabric in house construction may change as new data and reports are received from cooperating agencies. The following are suggestions based on experience so far, which, however, have been conducive to excellent results.

Type of material to use:

For roofing: A fire-resistant cotton duck of suitable weight for each particular job, and of a width most appropriate for the particular design of the house on which it is to be used.

No. 4 duck is preferable where the exposed roof surfaces are subject to hard usage, resulting from heavy snow, rainfall, or high winds. Where the weather conditions and usage are less severe, No. 6, No. 8, or No. 10 duck may be used.

For exterior side walls: No. 6, No. 8, or No. 10 cotton duck prefereably fire-resistant treated. The choice as to weight and fire-resistant treatment depends on climatic and other conditions.

For exterior porch ceilings: No. 6, No. 8, or No. 10 duck preferably fire-resistant treated.

For house decking: No. 2 or No. 4 cotton duck preferably fire-resistant treated.

Method of applying the cotton duck for each of the four components of houses, discussed above:

The cotton duck should be applied over a smooth backing such as tongue and groove sheathing, plywood, or other material that has been dressed smooth. The backing should contain no rough places, sharp edges or uneven surfaces.

In applying the cotton fabric over the backing material, the following procedure has been successfully followed:

1. Surfaces to which duck is to be applied are thoroughly cleaned and spread with a prime coat of lead and linseed oil paint. When the prime coat of paint is dry spread over it a layer of bedding cement. This cement is made from the same basic materials as that used in making the cotton fabric fire-resistant and is conducive to a good bond. Other adhesives which have an affinity for the compounds used in making the fabric fire-resistant may also be used (manufacturers of duck in some instances can supply such adhesive). A film of bedding cement about 1/64th inch is required. One gallon of bedding cement is sufficient for about 150 square feet of surface.

2. While the bedding cement is still tacky the duck is applied, being stretched slightly.

3. All exposed edges are securely fastened in place with 3/4 inch copper tacks spaced six inches apart. (For decking the edges should be tacked not over 3/4 inch apart and preferably 1/2 inch.)

4. The next strip of duck is then placed, made to overlap 1-1/2 inches on the strip previously laid and is tacked through the lapped edges with 3/4 inch copper tacks spaced two inches apart. (For decking the edges should be tacked not over 3/4 inch apart and preferably 1/2 inch.)

5. After tacking the 1-1/2 inch lap of one piece of duck over the other, it is then covered with a coat of bedding cement of the same color as that of the duck itself, or of a neutral color.

6. Where the duck intersects surfaces at right angle it is turned up not less than six inches and when necessary is flashed and counterflashed.

7. For the fire-resistant treated cotton duck, painting is not necessary for from six to 12 months. A coat of paint may be applied, however, immediately after the fabric is laid if it is so desired. Ordinarily lead and oil base house paint or preferably a paint having for its base the same compounds as those used in making the cotton duck fire-resistant, may be used. The use of the latter insures an affinity of the paint for the fire-resistant characteristics.

Cotton fabric for interior side walls and ceilings:

Cotton fabric being free of curls and buckles, flexible, and having characteristics which lend themselves to its being made sun-proof, water-proof, spot-proof, and fire-resistant, makes a splendid material for interior lining. It can be applied directly to studs and joists, it can be placed by an adhesive over plaster, plaster-board, and similar materials, and it can be made with figured designs in colors to harmonize with interior decorations and requirements.

Types of material to use:

The types of cotton fabric most suitable for use depend to a great extent upon the requirements to be fulfilled. They range from No. 8 and lighter cotton duck to fabrics commonly known as sheetings, print cloths, osnaburgs, and similar fabric.

Where the fabric is likely to be subject to frequent rubbing with the hands, or splashing of fluids, such as ink or grease, a spot-resistant material is desired. Cotton fabric reported to have these characteristics has been developed and plans have already been made by the Department to have its usefulness tested under actual servi

conditions in New York City. If it is to be placed in surroundings in which it is likely to come in contact with flames, fire-resistant treated fabric is preferable.

Method of applying cotton fabric:

Where the cotton fabric is to be applied directly to studs or joists with no backing material, such as cotton quilting (which acts as an insulation), plaster or plasterboard, it is nailed to the ground and to the studdings or joists. The material in this instance should be of a width some multiple of the spacing of the points to which it will be nailed. The edges of the fabric are overlapped about 1-1/2 inches and then tacked every four inches with 3/4 inch copper tacks. If butt joints are desired they are similarly nailed to the studdings or joists and the joints are covered with an overlapping strip of fabric and tacked or cemented securely.

Wherever the strips are cemented, care should be exercised to secure complete bond and the duck should be stretched slightly to make it taut. The use of a wooden hand roller is recommended to insure the best results in these respects.

Where the cotton fabric comes close to base-boards, window and door trim, and other wood elements of the structure, such elements are used as covers for the edges of the fabric lining. At the intersection of wall and ceiling surfaces a small, dark colored wood mold can be placed for the same purpose, thereby making it a practicable, workmanlike job.

In cases where the cotton fabric is not applied to a backing of some other material, No. 8, No. 10, or No. 12 cotton duck should be used.

Where the material is to be applied to plaster, plasterboard, and the like, either duck or lighter weight material is used and is applied in a manner similar to that used in applying wallpaper.

If it is desired, the cotton material for any component part of a structure can be applied in prefabricated construction at the point at which other component parts of the structure are made. In this manner roofs, side walls, partitions, and other parts of the structure are made at the factory and are ready for assembly when delivered to the building site.

In its use in prefabricated construction, the cotton fabric can be glued to plywood or other backing by "cold" or "hot" processes. In the cold process the cotton fabric is applied in the same manner as that used on a building when applying cotton material at the building site. In the hot process the cotton and plywood or other backing are joined under heat and pressure and becomes a unified whole so

closely bound together that their blending surfaces are scarcely distinguishable. Samples of such hot processed "reinforced" cotton fabric have been made and trial projects of their use in houses are being considered.

One architect has suggested that this reinforced material will also make excellent public shower bath partitions and the like.

Insulating value of cotton:

The purpose of insulation, generally, is to create warmer buildings in cold weather and thereby reduce fuel consumption to affect a maintenance economy, and to create cooler buildings in hot weather by insulating them against the sun's heat.

The efficiency of a material as insulation is expressed in terms of its thermal conductivity and one measure frequently used is the k90 coefficient. k90 expresses the amount of heat transferred in British Thermal Units at 90° Fahrenheit each hour, through one square foot of material, one inch thick, for every degree Fahrenheit of difference in temperature between a heated surface on one side and an unheated surface on the other (such for instance as between the inside and outside of a building). The lower the thermal conductivity or k90, therefore, the better the insulation.

Table 2 lists the thermal conductivity of cotton and of other materials. It is apparent from this table that the thermal conductivity of cotton fiber is relatively low.

TABLE 2. - Thermal Conductivity of Cotton

Material	Description	Density in pounds per cubic foot	k90
Cotton		2.0	0.250
		3.3	.239
Kapok	Silky vegetable fiber	0.09	.457
		0.18	.357
		1.0	.240
		2.0	.255
		4.0	.274
		6.0	.301
Rock wool	Fine fibers made from limestone rock	6.0	.258
		10.0	.268
		14.0	.277
		18.0	.268
Silk Oils	Waste from silk combings	.9	.256
Jute	Waste fibers	.9	.369
		1.2	.360
		1.2	.332
		2.3	.269
		3.5	.249
		9.0	.274
		12.3	.287

Adapted from table in Bureau of Standards Journal of Research, Vol. 5, November 1930.

Interior sound insulation:

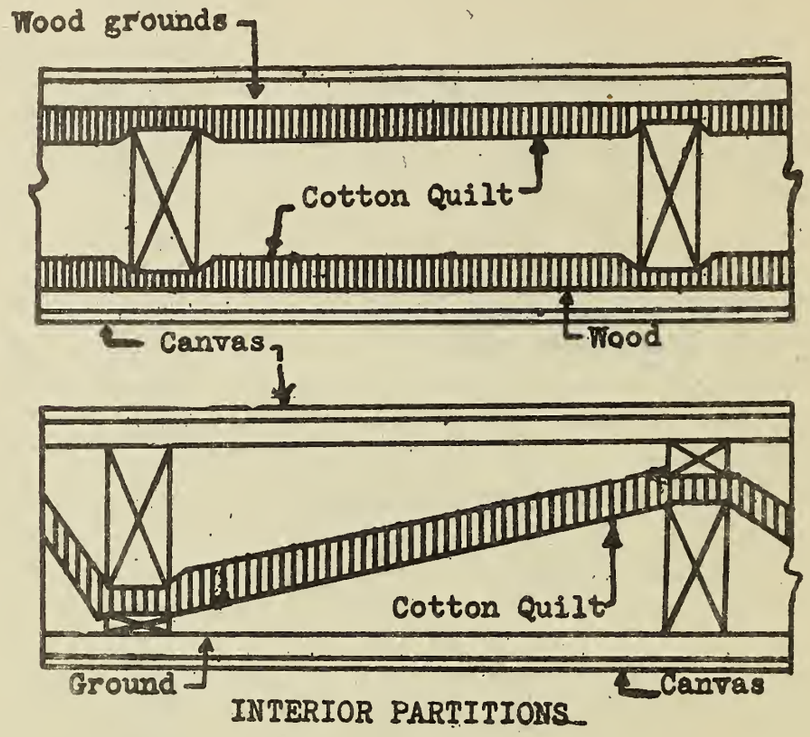
1. By first applying a 1/2 inch thick layer of cotton quilting to the ceiling joists, held in place by wood grounds, the latter in turn to be used later for fastening the finished cotton fabric surface, offices may be made semi-sound proof.

2. To obtain complete sound proofing, both the walls and ceilings may be lined with cotton quilting and then covered with cotton fabric as a finish.

3. Floors of frame buildings may be similarly sound proofed by using cotton quilting as a sound absorbant.

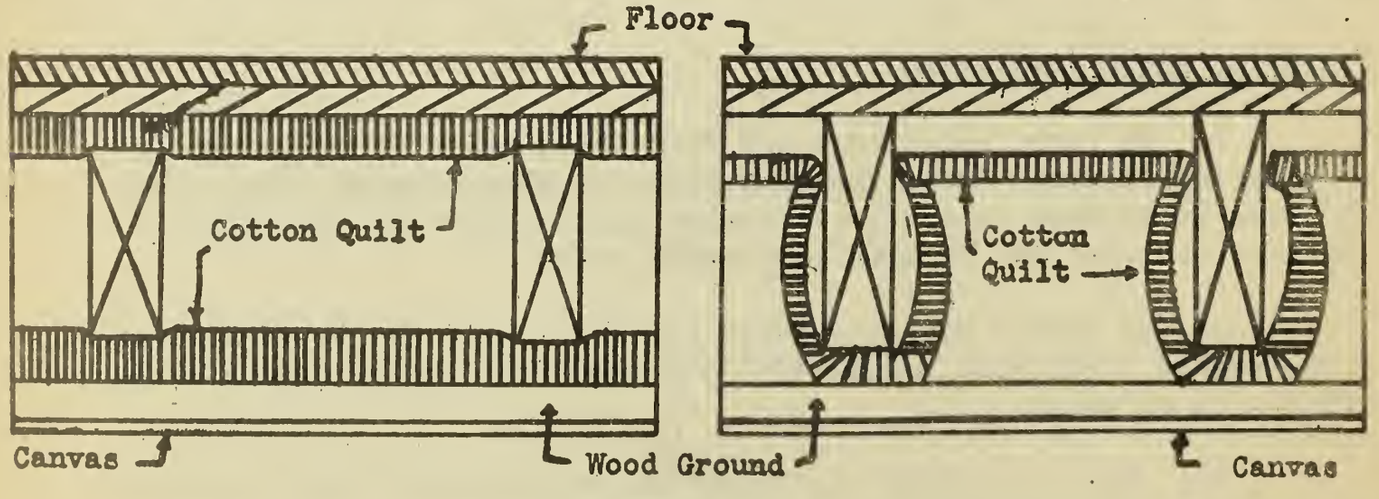
Sketches 2, 3, and 4 show the application of cotton for sound or heat insulation.

Sketch 2

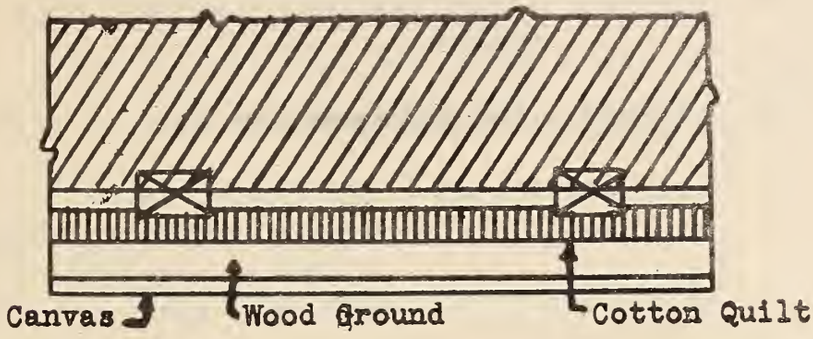


INTERIOR PARTITIONS

Sketch 3



Sketch 4



EXTERIOR WALL

Specifications of cotton insulation material:

1. Yarn requirements:

   a. Wales (warp): Cotton yarn, two or more ply.

   b. Courses (filling): Cotton roving or sliver, single or multiple but not exceeding ten strands.

2. Fabric requirements:

   a. Wales (warp): 16 wales to four inches. A minus tolerance of two wales and any plus tolerance is permitted.

   b. Courses (filling): 18 courses to six inches. A minus tolerance of two courses and any plus tolerance is permitted.

   c. Thickness: The thickness of the finished treated fabric is not less than 1/2 inch.

   d. Weight: Weight per square yard is not less than 3.7 pounds. When ten grams of the fabric are extracted for one hour in distilled water in a Soxhlet or similar extractor the loss in weight is not less than ten percent or more than 30 percent.

e. Width: Variable, up to 90 inches. A minus tolerance of 1/2 inch and a plus tolerance of one inch is permitted.

f. Sizing: The roving is to contain no sizing or filler.

g. Selvage: The selvages are knit or sewed.

h. Body and stitch: The fabric has a full firm body securely knitted together with a chain, single or double thread multiple needle stitch.

i. Fire-resistance: The fabric is treated and rendered of such fire-resistance that when samples each 12 by 4 inches in size cut from both directions of the fabric and applied vertically in length for eight seconds at a distance of one inch directly above the orifice of a shielded Bunsen or Turrell gas burner adjusted to give a luminous flame of 1-1/2 inches in height, the samples do not continue flaming longer than four seconds after removal from the flame and no glowing persists longer then two minutes.

This quilting comes in rolls 40 to 60 yards in length, and may be procured in widths up to 90 inches. Widths of 24-1/2, 36, and 54 inches, however are most readily obtainable.

Application of insulation:

For the present, cotton quilting of specifications listed on page 15 is recommended for exterior and interior insulation. It has a k90 thermal conductivity of about 0.37. The lap type of insulation, described below, shows considerable promise, however, and it may soon be possible to have such insulation available for general use. Recommendations as to insulation material will then be based upon special conditions attending each project from the standpoint of architectural design.

Cotton lap insulation:

Some parties interested in increasing the consumption of cotton are working on the development of a cotton insulating material having a density of about four to six pounds per cubic foot and bound by a sheet of light cotton fabric. If the efforts now being made are successful, there should soon be available a cotton insulating marial which is cheaper than that now being tried and one which can be manufactured at a much more rapid rate. It will have fire-resistant properties similar to the material now being used and a k90 thermal conductivity probably of about 0.24.

Exterior insulation:

Raw cotton fiber, in the form of half-inch thick quilting, may be applied to wood sheathed or metal deck roof surfaces for its value as insulation against cold before laying ply slag roofing.

After spreading an adhesive waterproof layer of asphalt over the roofing surfaces, then, while hot, the insulation quilting is imbedded in it.

The quilting comes in rolls and may be used in a single 1/2 inch or a double thickness of 1 inch. In using two layers, the second or top one should be laid in the opposite direction to the first one, or else, if laid parallel, the upper layer should overlap and have its continuous joints staggered over the lower layer.

Table 3. - Agencies Cooperating in the use of Cotton Fabrics for Use in Building Construction.
April, 1937 to January 7, 1939.

Cooperating Agency and Location of Project	Use	Duck No.	Color	Square Yard Equivalent
Forest Service, United States Department of Agriculture:				
Arcadia, California	Sidewalls	6	grey	770
Arcadia, California	"	10	"	1,100
Nevada City, California	"	6	"	770
Nevada City, California	"	10	"	1,100
Quincy, California	"	6	"	770
Quincy, California	"	10	"	1,100
Sonora, California	"	6	"	770
Sonora, California	"	10	"	1,100
Willows, California	"	6	"	770
Willows, California	"	10	"	1,100
Corbin, Kentucky	"	6		1,850
London, Kentucky	"	6		1,500
Beltsville, Maryland	"	6		171
Beltsville, Maryland	"	6	white	1,112
Watersmeet, Michigan	"	6		277
Bartlett, New Hampshire	"	6		555
Bridgewater, Virginia	"	6		200
Salem, Virginia	"	6		2,200
Elkins, West Virginia	"	6		1,673
Arcadia, California	Roofing	4	grey	1,650
Nevada City, California	"	4	"	1,650
Quincy, California	"	4	"	1,650
Sonora, California	"	4	"	1,650
Willows, California	"	4	"	1,650
Corbin, Kentucky	"	4	"	4,597
London, Kentucky	"	4	"	250
London, Kentucky	"	6	"	500
Beltsville, Maryland	"	4	"	1,660
Watersmeet, Michigan	"	4	"	2,685
Bartlett, New Hampshire	"	4	"	2,160
Sheffield, Pennsylvania	"	4	"	2,150
Bridgewater, Virginia	"	4	"	1,100
Salem, Virginia	"	4	"	5,621
Elkins, West Virginia	"	4	"	4,267
Arcadia, California	Insulation			1,520
Mt. Shasta City, California	"			3,460
Nevada City, California	"			2,300
Sonora, California	"			2,300
Corbin, Kentucky	"			3,616

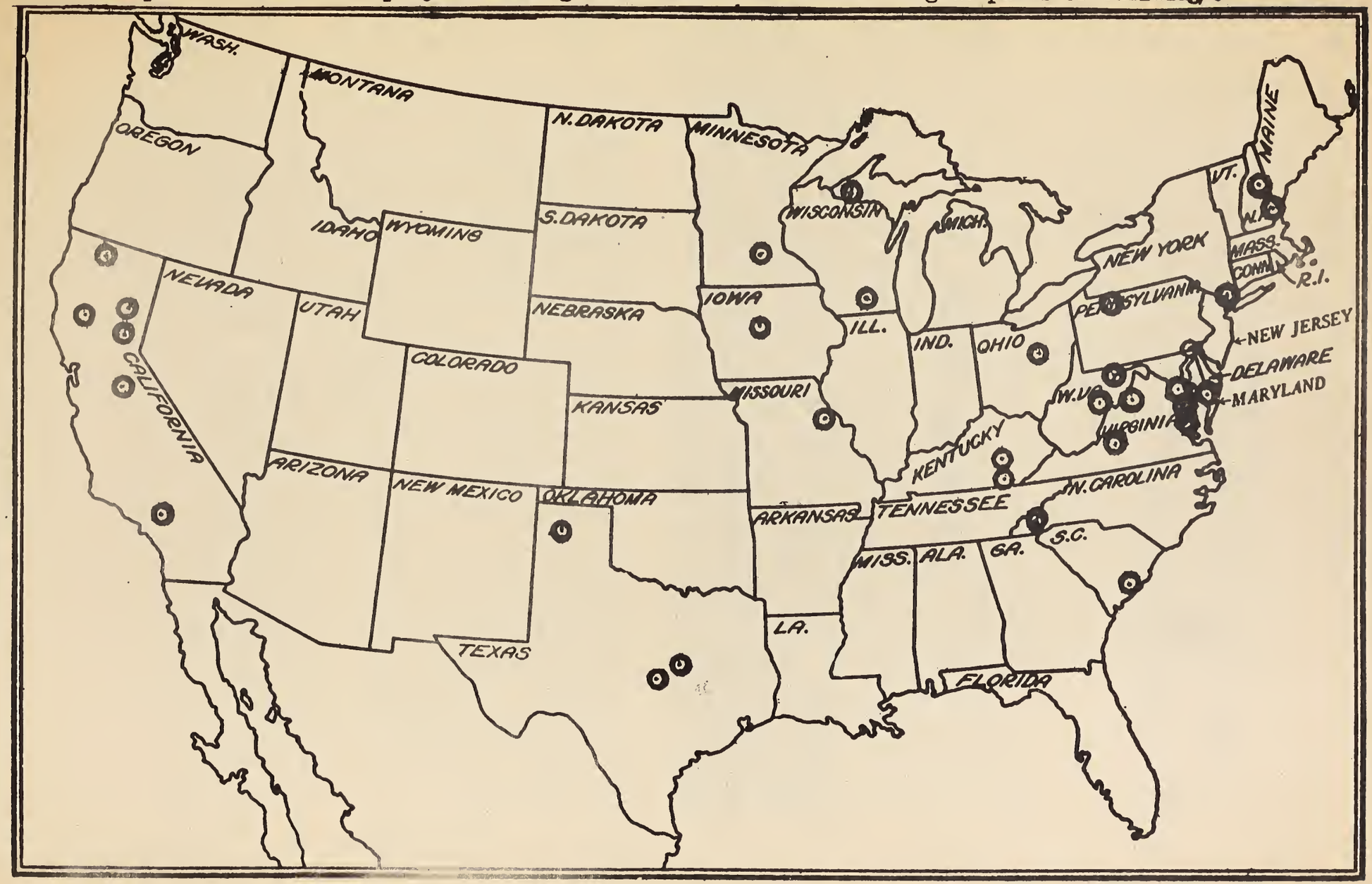
Table 3. - Continued

Cooperating Agency and Location of Project	Use	Duck No.	Color	Square Yard Equivalent
Beltsville, Maryland	Insulation			6,050
Bartlett, New Hampshire	"			3,471
Franklin, North Carolina	"			400
Sheffield, Pennsylvania	"			1,361
Salem Virginia	"			3,616
Elkins, West Virginia	"			3,616
Eagle River, Wisconsin	"			780
Soil Conservation Service, U.S. Department of Agriculture:				
Ames, Iowa	Sidewalls	2		20
Elsberry, Missouri	"	2		14
Ames, Iowa	Ceiling	2		6
Elsberry, Missouri	"	2		6
Ames, Iowa	Roofing	2		624
Elsberry, Missouri	"	2		730
Coshocton, Ohio	"	4		105
Bureau of Yards and Docks, U.S. Navy Department:				
Portsmouth, New Hampshire	"	2		1,570
Charleston, South Carolina	"	2		1,032
D. C. Department of Highways, Washington, D. C.	Sidewalls	6		2,516
	Roofing	6		2,516
Maryland State Department of Forestry:				
Berwyn, Maryland	Sidewalls	10	Khaki	100
North East, Maryland	"	4	Brown	1,050
North East, Maryland	"	4	Green	800
North East, Maryland	"	8	Khaki	1,950
Oakland, Maryland	"	4	Brown	2,100
Oakland, Maryland	"	4	Green	1,600
Oakland, Maryland	"	8	Khaki	3,900
Oakland, Maryland	"	10	Aluminum	1,500
Laurel Maryland	Insulation			612
North East, Maryland	"			1,701
Oakland, Maryland	"			2,042
Salisbury, Maryland	"			612
New York National Youth Administration:				
New York, N. Y.	Sidewalls	8	Orange	93
New York, N. Y.	Flooring	2	Green	27
New York, N. Y.	Roofing	4	Aluminum	67
New York, N. Y.	Insulation			93

Table 3. - Continued

Cooperating Agency and Location of Project	Use	Duck No.	Color	Square Yard Equivalent
Texas National Youth Administration:				
Burnet, Tex.	Sidewalls	8	Aluminum	9,995
Burnet, Tex.	"	6	White	1,611
San Jacinto, Tex.	"	8	Aluminum	3,332
San Jacinto, Tex.	"	6	White	1,806
San Jacinto, Tex.	"	4	Khaki	1,083
San Jacinto, Tex.	"	8	Terra Cotta	722
Waco, Tex.	"	8	Terra Cotta	722
Burnet, Tex.	Insulation			12,891
San Jacinto, Tex.	"			42,970
Waco, Tex.	"			4,764
Minnesota National Youth Administration:				
Shakopee, Minnesota	Sidewalls	10	White	3,000
Shakopee, Minnesota	Roofing	10	Green	3,000
Shakopee, Minnesota	Insulation			3,402
Forest Products Laboratory				
Madison, Wisconsin	Test Projects		(48 x 48)	17
Madison, Wisconsin	" "		(64 x 64)	17
Madison, Wisconsin	" "	12		17
	Total supplied for sidewalls			56,802
	Total supplied for roofing			42,884
	Total supplied for insulation			101,577
	Miscellaneous supplied			90
	Grand Total Quantities Cotton Supplied -			201,353

Map 1. - Location of projects making trial use of cotton as integral parts of buildings.



Indicates one or more projects

COTTON BALE COVERING

For many years there has been a desire among farmers and many in the cotton trade to have cotton used as a covering for cotton bales. This desire has been expressed not only because the use of cotton bagging provides a potential annual market for about 100,000 to 150,000 bales of cotton, but also because the many advantages believed inherent in cotton bagging would serve to offset much of the criticism which American bales now encounter, especially from foreign buyers.

Advantages claimed for cotton bagging include:

1. Neatness of package.
2. Economies in transportation.
3. Obviates practice of challenging and taring American cotton in spinners' markets.
4. Cotton lint does not adhere to cotton bagging as tenaciously as it does to bagging now generally used.
5. Strength.
6. Greater re-use value.
7. Increased consumption of cotton.

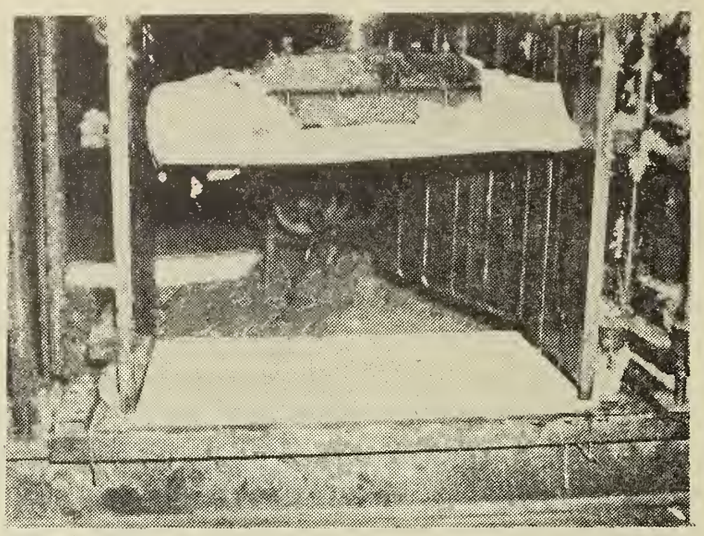
To determine the usefulness of cotton as wrappers for bales of American cotton, loosely woven cotton fabrics were supplied to cooperating agencies under provisions of the miscellaneous cotton diversion programs conducted by the Department in 1937 and 1938. A total of about 37,000 patterns were supplied under these programs for use in covering bales of Sea Island cotton and Upland cotton.

This trial use of cotton bagging gave very satisfactory results. The tests, however, were not enough in themselves to establish the general use of cotton as a covering for bales of cotton, and a separate cotton bagging program was therefore initiated. Under this program, a maximum of 1,000,000 cotton patterns is made available to eligible purchasers at a basic cost of 45 cents per pattern.

The separate program was not made effective until late in the summer of 1938, hence only small quantities were utilized for the 1938 crop. Under the program, however, cotton bale covering can be sold until June 30 and deliveries made until September 30, 1939. This should make possible its considerable use for the 1939 crop. The successful bidder for the manufacture of the cotton bale covering was determined on a competitive basis. The manufacturer is paid 28 cents over and above the 45 cents received from the purchaser for each pattern sold under the program, or 73 cents per pattern. This total of 73 cents is about equal to the cost during 1938 of new bagging materials other than cotton.

The reduced price at which the cotton bale covering is thus made available partially offsets the artificial advantage which gross weight trading gives to heavier types of bagging. Since the new cotton bagging program has been in effect, however, mills representing about 10,000,000 spindles have agreed to make an allowance for differences in weight between jute and cotton patterns in their purchase of cotton covered with the latter.

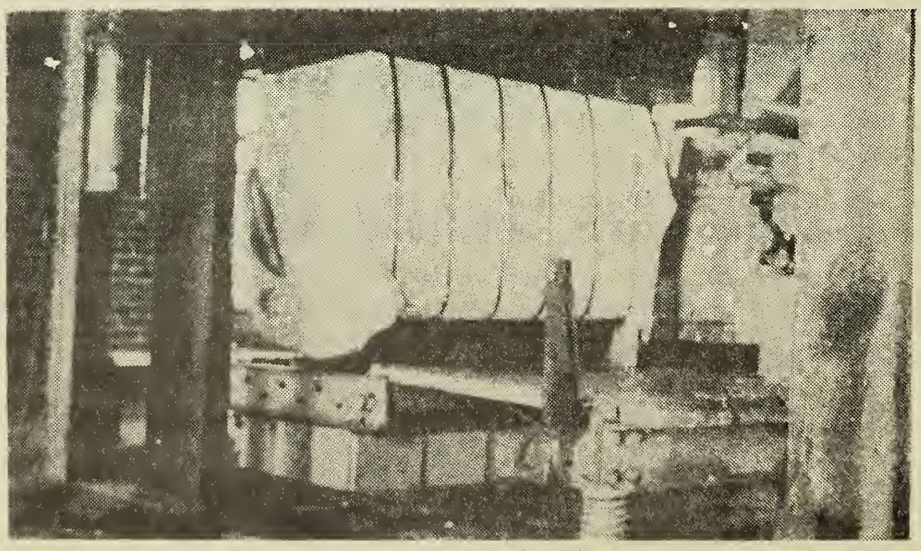
Photograph 8



Photograph courtesy of Extension Service, University of Georgia.

View of cotton bagging on press used in the baling of Sea Island cotton, (photograph 8).

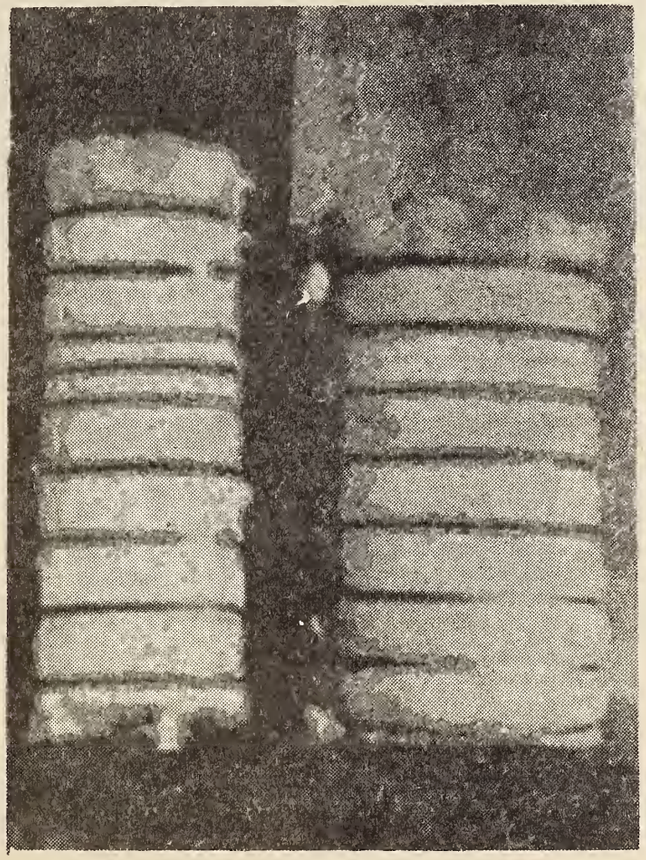
Photograph 9



Photograph by Marketing Section, Agricultural Adjustment Administration, United States Department of Agriculture.

Bale of cotton covered with cotton bagging being taken from gin box at State College, Mississippi, (photograph 9). Note the draping of cotton fabric on the ends of the bale, the nearest end of the bale can be clearly seen. The draped ends are turned under and held securely by the tightened bands.

Photograph 10



Photograph by Marketing Section, Agricultural Adjustment Administration, United States Department of Agriculture.

Left, high density bale, and right, standard density bale, United States Ginning Laboratory, Stoneville, Mississippi, (photograph 10). The high density bale is generally used for export and the standard density bale for shipment to American mills.

Photograph 11

Photograph by Marketing Section, Agricultural Adjustment Administration, United States Department of Agriculture.

Uncompressed bales at State College, Mississippi, (photograph 11). Top bale in center covered with jute bagging, remaining bales covered with cotton.

Photograph 12

Photograph courtesy of United States Ginning Laboratory, Stoneville, Mississippi.

Cotton covered bales of cotton ready for shipment, (photograph 12). Two cut lengths of fabrics (called a pattern) are required for each bale.

Cotton bagging supplied under miscellaneous cotton diversion programs:

Cotton patterns made of three types of fabric were supplied to cooperating agencies under provisions of the miscellaneous cotton diversion program from July 1, 1937 to January 7, 1939. These patterns were supplied for use in covering bales of Sea Island cotton and bales of Upland cotton.

Following are minimum specifications of fabrics used in covering bales of Sea Island cotton:

a. 8 x 8 fabric used in 1937 1/ :

Width: 40 inches.
Weight per three linear yards: 2.25 pounds.
Yarn: Single.
Weave: Plain.
Warp threads per 12 inches: 96
Filling threads per 12 inches: 96
Average breaking strength:
Warp: 190 pounds.
Filling: 190 pounds.

b. 15 x 10 fabric used in 1938:
Width: 57 inches.
Weight per three linear yards: 3 pounds.
Yarn: Single.
Weave: Plain.
Warp threads per 12 inches: 180.
Filling threads per 12 inches: 120.
Average breaking strength:
Warp: 250 pounds.
Filling: 150 pounds.

1/ In 1937 only a few hundred patterns of 8 warp and 8 filling threads per inch, 40 inches wide material were tried. In its use it was determined that a fabric having about 15 warp and 10 filling threads, 57 inches wide would be more suitable. The increase in width was made so that the fabric would completely cover the bale of Sea Island cotton.

Following are minimum specifications and a photograph of fabric used in covering bales of Upland cotton. Cotton patterns supplied under provisions of the cotton bagging program for 1,000,000 patterns are also made of this type of fabric.:

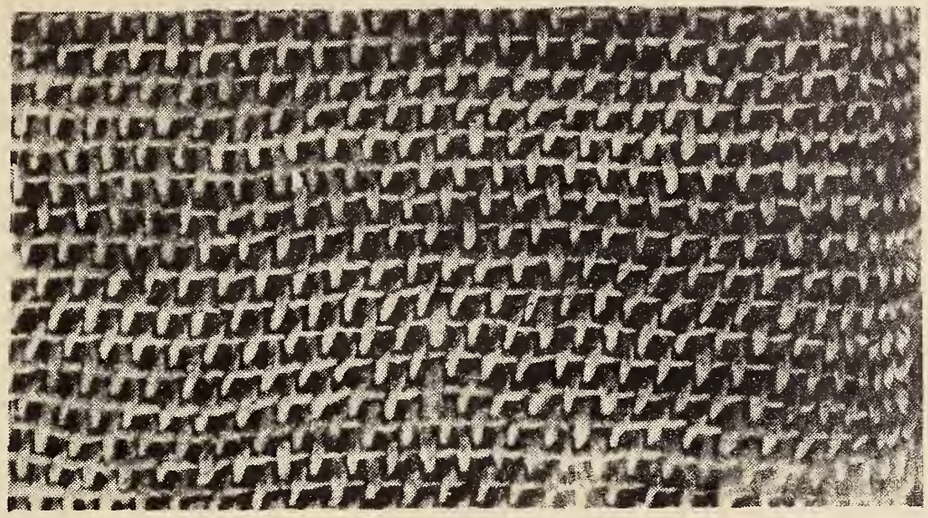
11 x 6 fabric:

Width: 45 inches.
Weight per three linear yards: 2.25 pounds.
Yarn: Single.
Weave: Plain.
Warp threads per 12 inches: 132.
Filling threads per 12 inches: 72.
Average breaking strength:
Warp: 300 pounds.
Filling: 150 pounds.

Tolerances permitted are:

Width: Any plus, or minus one inch.
Length: Plus or minus 2-3/4 inches.
Weight: Plus or minus 5 percent.
Thread count:
Warp: Plus or minus three threads per 12 inches.
Filling: Plus or minus 2 threads per 12 inches.
Breaking strength: Any plus, no minus.

Photograph 13



Photograph by Marketing Section, Agricultural Adjustment Administration, United States Department of Agriculture.

Actual scale photograph of 11 x 6 fabric (photograph 13).

Tables 4 and 5 show the number of patterns and square yard equivalents supplied under the miscellaneous program by states for use in covering bales of Sea Island and bales of Upland cotton but excludes bagging sold under the 1,000,000 pattern program.

Table 4. - Cotton bagging supplied from July 1, 1937 to June 30, 1938, by States.

Supplied for use in covering bales of Sea Island cotton:

State	Number of patterns	Square yard equivalent
Florida	5,725	54,736
Georgia	4,308	40,971
South Carolina	10	100
Total	10,043	95,807

TABLE 4. - continued

Supplied for use in covering bales of Upland cotton:

State	Number of patterns	Square yard equivalent
Alabama	20	150
Arizona	78	581
Arkansas	4,966	37,241
California	83	675
Georgia	95	713
Mississippi	5,600	42,000
New Mexico	60	450
North Carolina	550	4,125
Oklahoma	60	450
South Carolina	575	4,313
Texas	3,000	22,500
Total	15,087	113,198
Grand Total	25,130	209,005

Table 5. - Cotton bagging supplied from July 1, 1938 to June 30.., 1939, by States.

Supplied for use in covering bales of Sea Island cotton from July 1, 1938 to January 7, 1939:

State	Number of patterns	Square yard equivalent
Georgia	1,050	9,975
South Carolina	10	95
Total	1,060	10,070

Supplied for use in covering bales of Upland cotton from July 1, 1938 To January 9, 1939, excluding bagging sold inder the 1,000,000 pattern program:

State	Number of patterns	Square yard equivalent
Georgia	100	750
Louisiana	400	3,000
Mississippi	2,750	20,625
Oklahoma	4,100	30,750
Texas	3,350	25,875
Total	10,700	81,000
Grand Total	11,760	91,070

Net weight trading:

The existing system of gross weight trading places an artificial barrier against the use of cotton covering and is a major disadvantage which must be overcome if the use of cotton bagging is to be generally accepted.

Under the present system of gross weight trading, the farmer is paid a given amount per pound for the total weight of the bale, which includes the weight of bagging and ties as well as the weight of the raw cotton. Obviously, the usual amount of tare is reflected in the price. For the individual farmer, however, any deduction in the weight of tare, reduces by that amount the weight of the bale and the poundage on which payment is received. Since jute bagging usually weighs about 12 pounds per pattern, and cotton bagging weighs only 4-1/2 pounds per pattern, if no provision is made to protect the farmer who uses cotton bagging, he loses 7-1/2 pounds in weight on each bale. This loss may easily equal or exceed the entire cost of jute bagging and operates as an artificial trade barrier against the adoption of any lightweight bagging. The practice perpetuates the use of excessively heavy bagging and patches, which can be purchased at a lower price per pound than cotton. The costs of shipping and handling this excess tare and of testing to determine whether the tare is within the established tolerances, are material.

In an effort to eliminate this difficulty, mills having about ten million spindles have agreed to make an allowance for the difference in weight between cotton bagging and bagging now generally used. Furthermore, an amendment to the 1938 cotton loan program provides an additional allowance of 65 cents per bale on cotton wrapped in cotton covering. This added allowance of 65 cents per bale for cotton covered bales reflects approximately the value during the season of 1937-38 of the additional 7-1/2 pounds of lint cotton in the bale.

The farm value of 7-1/2 pounds of cotton , by crop years, from 1928-29 to 1937-38 is given in table 6.

Table 6. - Farm value of 7-1/2 pounds of cotton 1928-29 to 1937-38

Year ending July 31	Weighted average price received by farmers	
	Per pound	For 7-1/2 pounds
	cents	cents
1929	17.99	134.9
1930	16.79	125.9
1931	9.46	70.9
1932	5.66	52.4
1933	6.52	48.9
1934	10.17	76.3
1935	12.36	92.7
1936	11.09	83.2
1937	12.33	92.5
1938	1/ 8.40	63.0
Average 1929 to 1938	11.07	83.1

Source: United States Department of Agriculture, Agricultural Statistics 1938, Table 126.

1/ Preliminary.

Table 7 lists the premiums in price for cotton wrapped in 3/4-pound cotton material when purchased on a gross weight basis and when purchased on a net weight basis. Approximately the same results are attained if a flat allowance of 7-1/2 pounds is added to a bale wrapped in cotton bagging and the total weight thus obtained is multiplied by the price on a gross weight basis.

Table 7. - PREMIUMS IN PRICE FOR COTTON WRAPPED IN 12-OUNCE COTTON MATERIAL WHEN PURCHASED (A) GROSS WEIGHT (B) NET WEIGHT

Ordinary bale covering weighs 2 pounds per yard or 12 pounds per bale. Cotton material weighs only 12 ounces per yard or 4½ pounds per bale. The following table shows the proper allowance or premium to be added to the price, (a) if cotton wrapped bales are bought on a gross weight basis, and (b) if cotton is bought net weight, with the weight of bagging and ties deducted from the weight of the bale.

When price per pound gross weight for cotton in 2-pound bagging is	(A) For cotton in 3/4-pound cotton covering if bought: gross weight add	(B) For cotton bought net weight add
Cents	Cents	Cents
5.00	.08	.23
6.00	.09	.28
7.00	.11	.32
8.00	.12	.37
9.00	.14	.41
10.00	.15	.46
11.00	.17	.51
12.00	.18	.55
13.00	.20	.60
14.00	.21	.64
15.00	.23	.69
16.00	.24	.74
17.00	.26	.78
18.00	.27	.83
19.00	.29	.87
20.00	.30	.92
0.05	.00	.00
.10	.00	.00
.15	.00	.01
.20	.00	.01
.25	.00	.01
.30	.00	.01
.35	.01	.02
.40	.01	.02
.45	.01	.02
.50	.01	.02
.55	.01	.03
.60	.01	.03
.65	.01	.03
.70	.01	.03
.75	.01	.03
.80	.01	.04
.85	.01	.04
.90	.01	.04
.95	.01	.04

Example:- If the gross weight price (in 2-pound bagging) is 8.45 cents per pound, the gross weight price in 3/4-pound cotton bagging (a) would be 8.58 cents; and the net weight price (b) would be 8.84 cents per pound. These equivalents are obtained from the above table as follows:

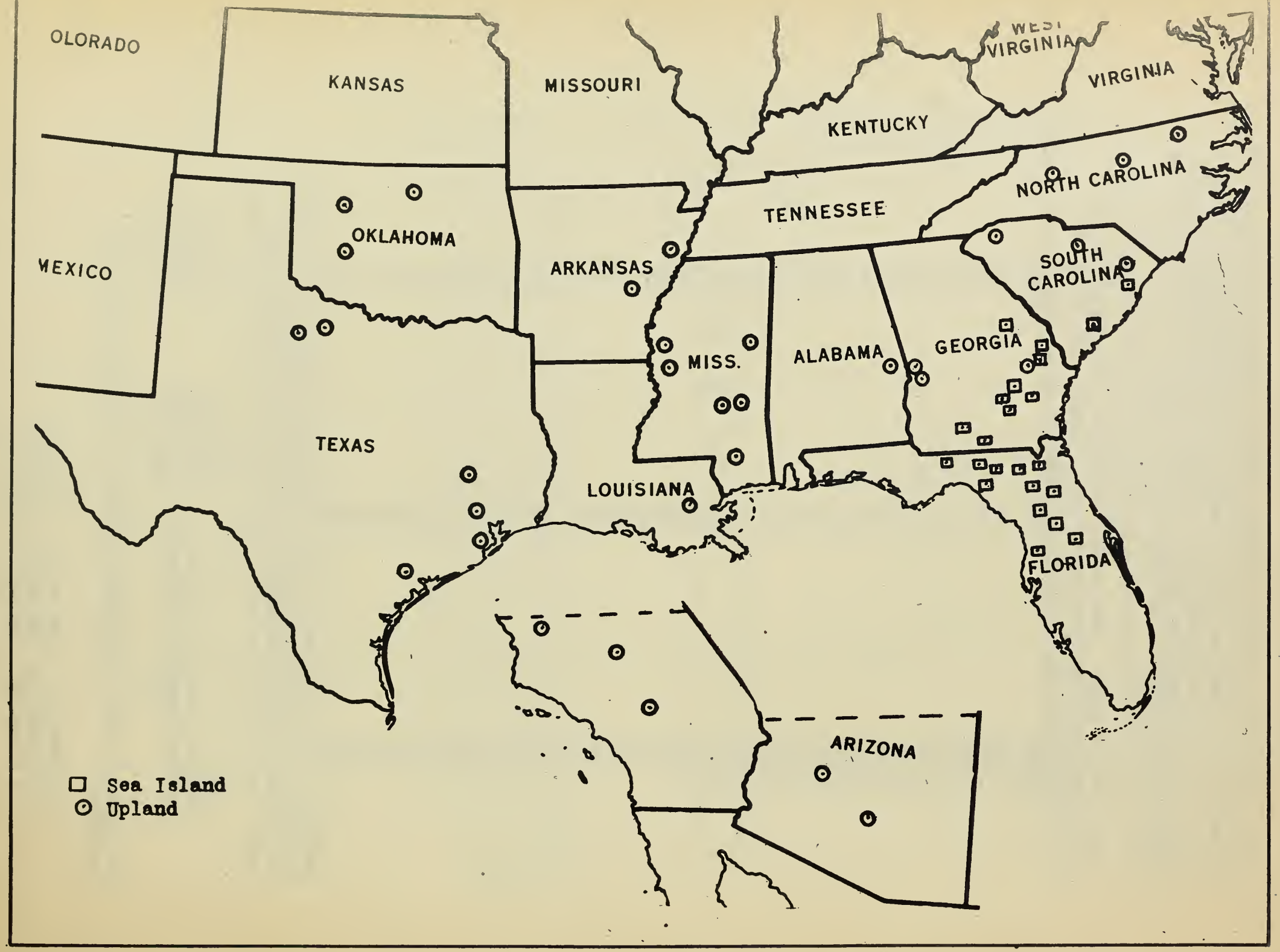
	(a)	(b)
Price	8.45 cents	8.45 cents
Premium (shown for 8 cents)	.12 cents	.37 cents
Premium (shown for 0.45 cents)	.01 cents	.02 cents
Total	8.58 cents	8.84 cents

The value of a bale (containing 478 pounds of cotton in each case) would be:

500 pounds at 8.45 cents = $ 42.25
492½ pounds at 8.58 cents = $ 42.25
478 pounds at 8.84 cents = $ 42.25

Source: Marketing Section, A.A.A., U. S. DEPARTMENT OF AGRICULTURE.

Map 2. - Location of projects utilizing cotton bagging for cotton bales.



⊙ ⊡ Indicate location of one or more projects.

DITCH AND CANAL LININGS

Ditches for handling intermittent flows of water are necessary in those parts of the country which are subject to periodic deluges of rain. Canals for the carrying of irrigation water are needed in the arid sections of the United States. The side slopes and bottoms of such ditches and canals are subject to erosion. To offset this tendency, it is essential that a lining material which will not crack or crumble be applied.

Included among the materials now being tested for this purpose is asphalt or other bituminous materials reinforced with cotton fabric. The cotton fabric, when imbedded in the asphalt on the bottoms and side walls of canals and ditches, holds the asphalt in place and prevents its disintegration. In many respects the principle is much the same as in its use in cotton fabric reinforced bituminous surfaced roads.

Photographs 14 to 18 illustrate the use of cotton fabric in lining an irrigation canal near Grace, Idaho. The Bureau of Agricultural Engineering, United States Department of Agriculture, carried on the tests and supervised the work.

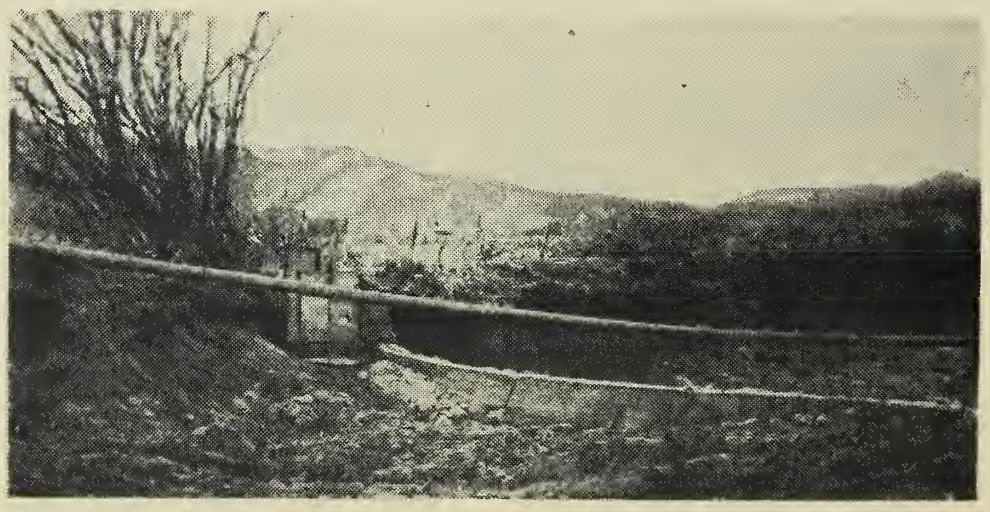
Photographs 20 to 23 illustrate the use of cotton fabric in the lining of irrigation ditches seeded to erosion resisting grasses. This work was done by the Pacific Northwest Region, Soil Conservation Service of the United States Department of Agriculture.

Photograph 24 pictures the work of Region II of the Soil Conservation Service, United States Department of Agriculture, in lining a terrace outlet channel with cotton fabric.

Photographs 26 to 29 show the use of cotton fabric in the lining of a reservation flume. This project was conducted at Yuma, Arizona, by the Bureau of Reclamation of the United States Department of the Interior. The use of cotton fabric by that Bureau for lining a storage tank is pictured in photograph 30.

The cotton fabric for all these projects was supplied by the Marketing Section of the Agricultural Adjustment Administration, United States Department of Agriculture.

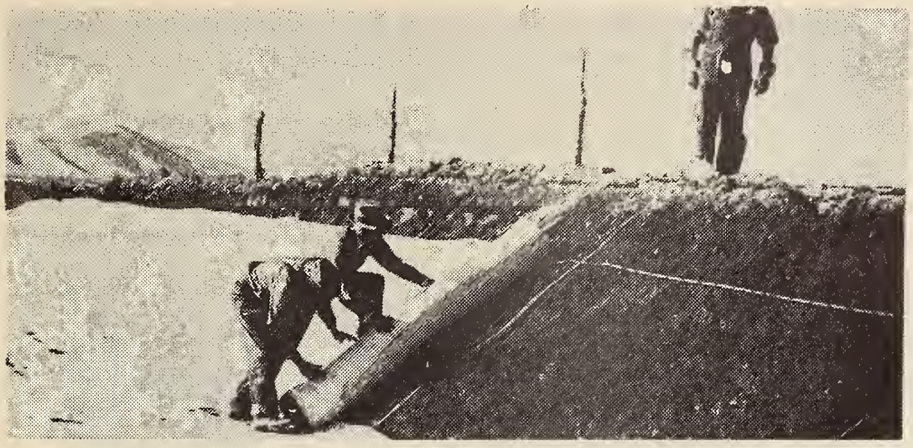
Photograph 14



Photograph courtesy of Bureau of Agricultural Engineering, United States Department of Agriculture.

View of canal before side slopes and bottom were smoothed, (photograph 14).

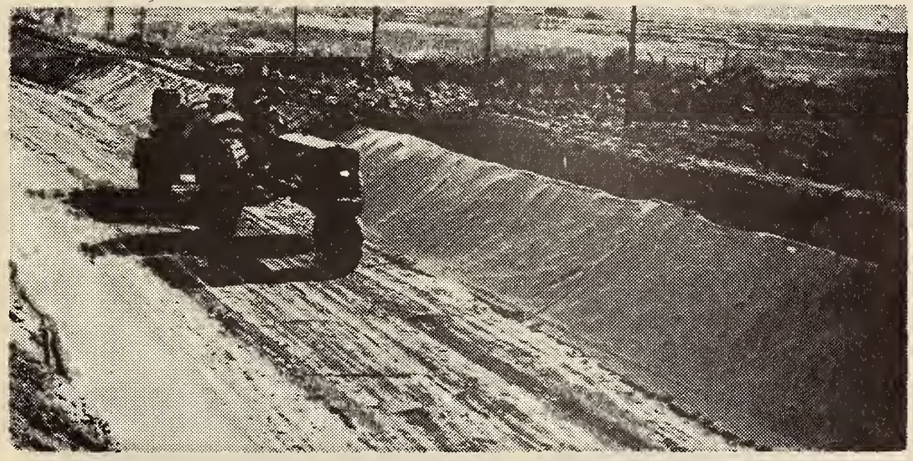
Photograph 15



Photograph courtesy of Bureau of Agricultural Engineering, United States Department of Agriculture.

View of laying the cotton fabric to the side slopes of the canal, (photograph 15). The slopes are first smoothed, and roots, sticks, and irregular places are removed. A coat of asphalt is applied, over which cotton fabric is laid, overlapping one strip over another four to twelve inches. A coat of asphalt is then spread over the cotton fabric. A fabric containing 9 warp and 9 filling threads per inch was used.

Photograph 16

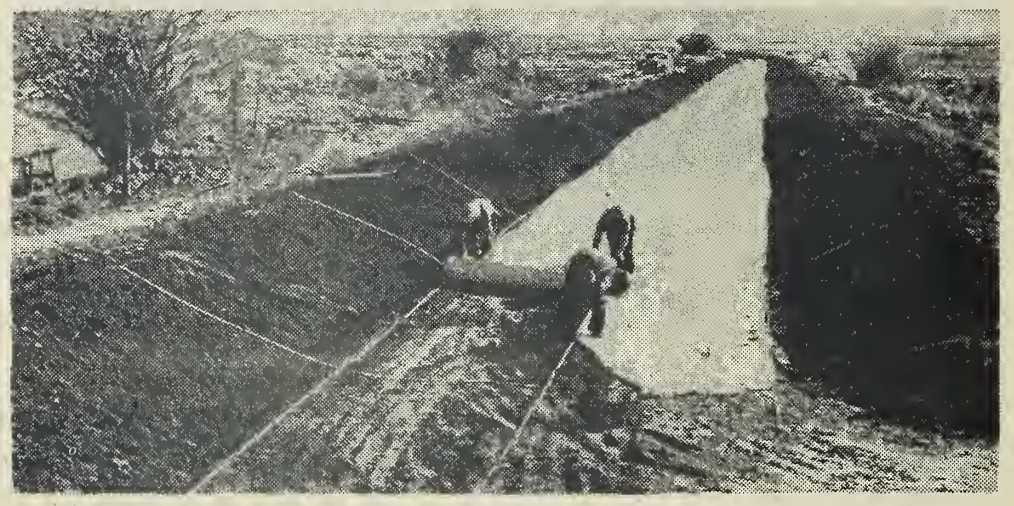


Photograph courtesy of Bureau of Agricultural Engineering, United States Department of Agriculture.

View of cotton fabric on side slope being spread with a top coat of asphalt.

In the foreground can be seen fabric just before being sprayed and in the background can be seen application of the asphalt, (photograph 16).

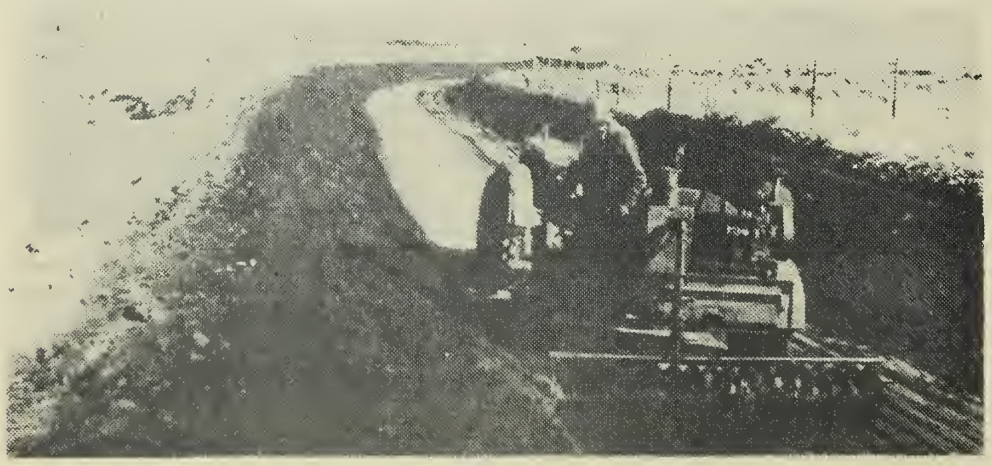
Photograph 17



Photograph courtesy of Bureau of Agricultural Engineering, United States Department of Agriculture.

When the side slopes are covered, the bottom of the canal, after being smoothed, receives the cotton fabric over which two coats of asphalt are applied. Photograph 17 shows the laying of cotton fabric to the bottom of canal. Metal strips to hold the cotton fabric in place when the asphalt is being applied may be seen. The use of such strips often is not necessary.

Photograph 18



Photograph courtesy of Bureau of Agricultural Engineering, United States Department of Agriculture.

View showing application of bituminous material over fabric laid on the bottom of the canal, (photograph 18).

The last report received in connection with the above illustrated project stated: "The extreme low cost of this type of lining, together with its durability and successful application in this experiment, should tend to promote its use extensively in the near future."

Specific findings reported include:

1. Although slopes steeper than 2 to 1 are not recommended, fabric laid on a two-hundred foot section of a 1-1/2 to 1 slope through a rock cut has held well.

2. Prior to lining, between 20 and 30 percent loss had been sustained for years during the irrigation season, with flows ranging between 200 and 100 cubic feet per second. Meter measurements taken after completing lining showed an average loss of 0.4 percent with an average flow of 106 cubic feet per second.

3. Periodic inspections showed no disintegration of the lining due to water flow in the canal.

4. No sluffing of oil on the bank slopes above the water line due to extreme temperatures was noticeable except in a few small places where the oil surface had not been properly covered with mop coat.

5. The only moss growth noticed in the lined section was a slight growth of hair moss which had no dilatory effect upon the water flow.

6. Top banks treated with sodium chlorate were free from all vegetable growth.

7. No noticeable damage from frost ravages and winter weather.

8. Prior to lining, canal was troubled greatly with gophers.

After lining, they had apparently left as no gophers or gopher holes were noticeable.

Method of Application:

The method of applying cotton fabric as a reinforcing membrane is not standardized. Trials now being conducted by cooperating agencies cover various materials and methods of application. The following recommendations, offered by one of the cooperating agencies, have been compiled on the basis of experience gained in the application of fabric.

1. Establish proper grades and alignment. Compact all deposited soil when laid. Make inside slopes slightly full. Secure a smooth even surface for light oil application by cutting to a true line with a tilted blade machine or through settlement with water and heavy rolling.

2. Treat all banks and surfaces with sodium chlorate, seven pounds to the square rod.

3. Spray light penetrating oil, heated to 200 to 300 degrees, at rate of at least one half gallon to the square yard.

4. Allow oil to penetrate and dry for about two days. Spray with 95 percent asphaltic oil, one-fourth gallon to the square yard.

5. Lay longitudinal strips of 20 gage hoop steel, one inch wide and punctured with 3/8-inch lugs and bent at right angles to the steel, as wide apart as four inches less than the width of the fabric; transverse sections of steel, cut one foot longer than the width of the fabric, should be laid every eight feet.

6. Unroll fabric and fasten to the upright lugs on the steel strips. Roll lugs flat with a hand roller.

7. Spray fabric with 95 percent asphaltic oil, heated as before, one-fourth gallon to the square yard.

8. Spread stone chips, crushed to a size 1/8-inch to 5/8-inch, over surface, 50 pounds to the square yard.

9. This surface may then be traveled on and parallel strips laid in a like manner, rolling down the steel lugs on the longitudinal strips after both fabric sections have been lapped.

All steel strips should be stapled with long wire staples. The transverse steel battens laid on the banks should be cut long enough to lap at least six inches at the lower end and have at least one foot to bend down and insert at the upper edge of the bank.

10. After the stone chip coating is completed, spray with 95 percent asphaltic oil, one-half gallon to the square yard, doing the banks first with a side bar nozzle and completing the bottom with a rear bar nozzle.

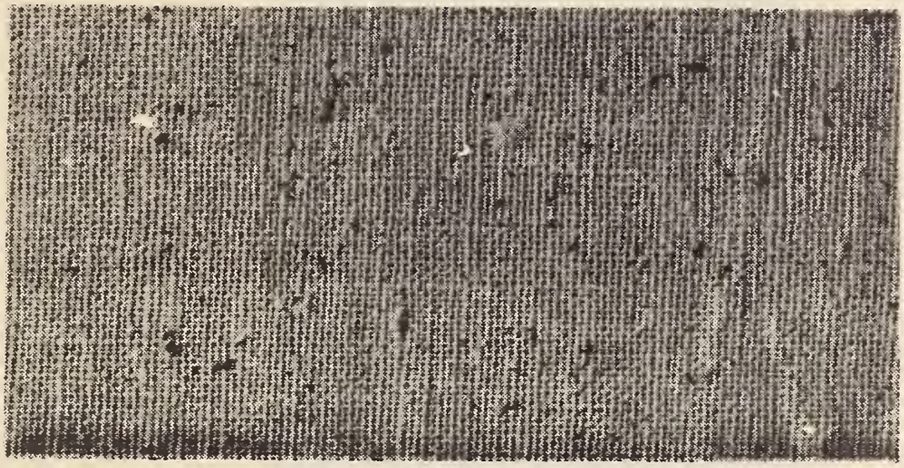
11. Apply mop coat of screenings with the dust removed, sizing from sharp sand to 1/8-inch chips, to the whole surface at rate of five pounds to the square yard.

12. Roll entire surface well.

Types of Fabric Supplied:

Four types of fabric were supplied to cooperating agencies for use as a reinforcing material in the lining of irrigation ditches and canals and terrace outlet ditches. These include the three types of fabric shown in photographs 42, 43, and 44. Also supplied was a fabric containing 40 warp threads and 28 filling threads per inch, a description of which follows:

Photograph 19



Photograph by Marketing Section, United States Department of Agriculture.

Actual scale photograph of fabric containing 40 warp and 28 filling threads per inch, (photograph 19).

Minimum Specifications:

Osnaburg fabric, single yarn, plain weave.

Width: 40 inches.

Thread count:
Warp: 40 threads per inch.
Filling: 28 threads per inch.

Weight per square yard equivalent: 7.0 ounces.

Breaking strength:
Warp: 57 pounds.
Filling: 57 pounds.

Cotton Lining Without Bituminous Material:

Photograph 20

Photograph courtesy of Pacific Northwest Region, Soil Conservation Service, United States Department of Agriculture.

View of unlined ditch, lying on a gradient of about 5 percent, showing considerable erosion by irrigation water running for a period of three days, (photograph 20). Treatment consists of properly shaping the ditch, seeding to an erosion resisting grass mixture, and lining with cotton fabric.

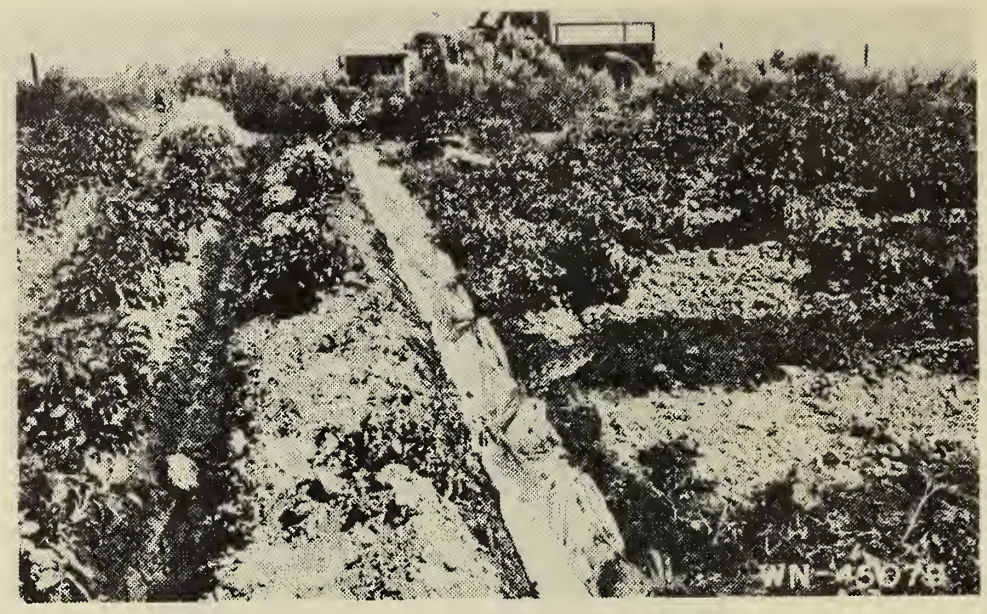
Photograph 21

Photograph courtesy of Pacific Northwest Region, Soil Conservation Service, United States Department of Agriculture.

View of irrigation ditch with fabric in place. This photograph was taken after the lined ditch had been in use during the irrigation season lasting from May 1 to October 15. The cloth is partly decayed but has prevented the loss of any soil by erosion. Bulges under the fabric on the ditch bank opposite the hat, are caused by the growth of grass, (photograph 21).

In placing the fabric, the cloth is laid to fit the ditch as nearly as possible, and is held in place by shovelsful of earth, by rocks, or with long wire staples. The fabric should be treated to prevent decay. Asphalt, coal tar distillate, or similar material is effective for such treatment.

Photograph 22



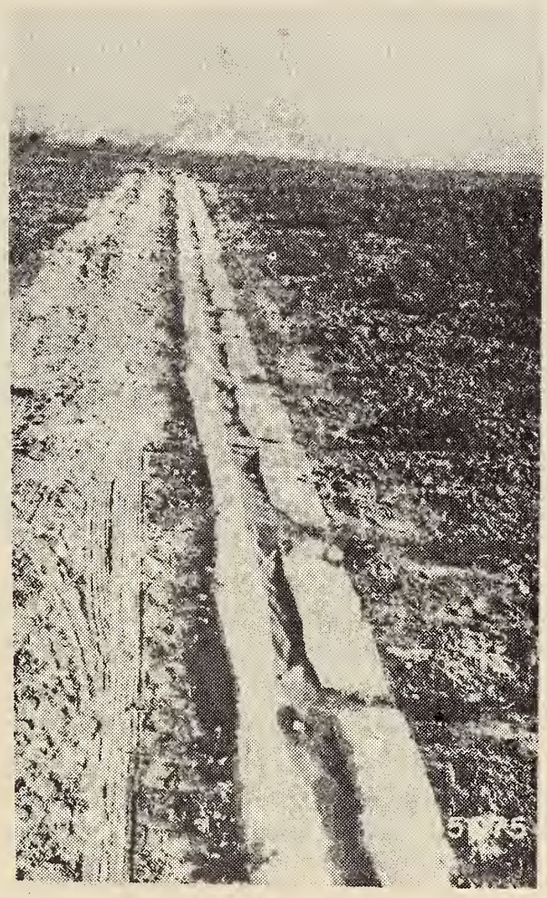
Photograph courtesy of Pacific Northwest Region, Soil Conservation Service, United States Department of Agriculture.

Waste water from the contour irrigated potato field on the right is being collected in the cloth-lined ditch to prevent severe erosion. The fabric is molded to fit the ground and held in place with wire loops, (photograph 22).

Cotton fabric containing 80 warp and 80 filling threads per inch was reported to have given excellent results for this purpose.

Photograph 23 shows water flowing through an irrigation head ditch lined with cotton fabric. This ditch, carrying an intermittent head of as much as one second foot on a gradient of 8 percent, was adequately protected and no erosion took place. In head ditches, the use of the fabric, in addition to preventing soil washing, aids in controlling water entering the irrigation corrugations.

Photograph 23



Photograph courtesy of Pacific Northwest Region, Soil Conservation Service, United States Department of Agriculture.

Linings for Terrace Outlet Channels:

Photograph 24

Photograph courtesy of Region II, Soil Conservation Service, United States Department of Agriculture.

View of terrace outlet channel mulched with cotton fabric, (photograph 24). A cotton fabric containing 17 ($4\frac{1}{4}$ x 4) warp and 5 filling threads per inch was used in the above project. The channel is sprigged with Bermuda sod and mulched with cotton fabric placed lengthwise. The fabric is anchored with wire staples driven at intervals of approximately three feet. Water from terraces was discharged immediately on the areas without incurring damage.

Cotton fabric used in terrace outlet channels may be taken up as soon as the vegetation has established a satisfactory root system and used again on other jobs until it finally becomes unserviceable. This fabric was found to be most suitable as a mulching material and when used on sodded areas, excellent vegetation resulted.

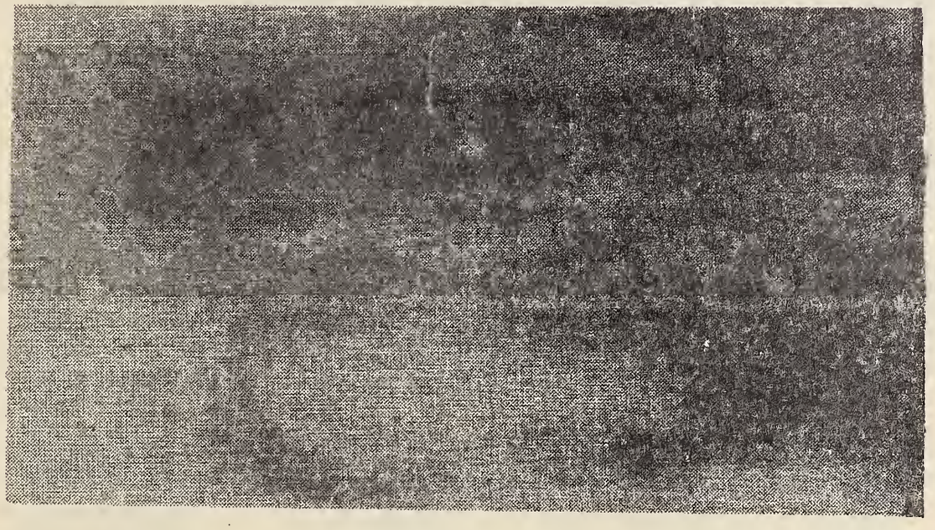
Types of Fabric Supplied:

Three types of fabric, supplied to cooperating agencies, were used for the above-pictured purposes. These included fabrics containing 9 warp and 9 filling threads per inch, 17 ($4\frac{1}{4}$ x 4) warp and 5 filling threads per inch, and 80 warp and 80 filling threads per inch. Minimum specifications and photographs of the 9 x 9 fabric are included in the section entitled "Cotton for Roads, Streets, and

Airport Runways," (pages 69 to 71); of the 17 x 5 fabric in the section headed "Cuts and Fills," (pages 59 and 60).

Following is a description of the 80 x 80 fabric:

Photograph 25



Photograph by Marketing Section, Agricultural Adjustment Administration, United States Department of Agriculture.

Actual scale photograph of fabric containing 80 warp and 80 filling threads per inch, (photograph 25).

Minimum Specifications:

Single ply yarn, plain weave.

Width: 39 inches.

Thread count:
Warp: 80 threads per inch.
Filling: 80 threads per inch.

Weight per square yard equivalent: 3.7 ounces.

Breaking strength:
Warp: 60 pounds.
Filling: 45 pounds.

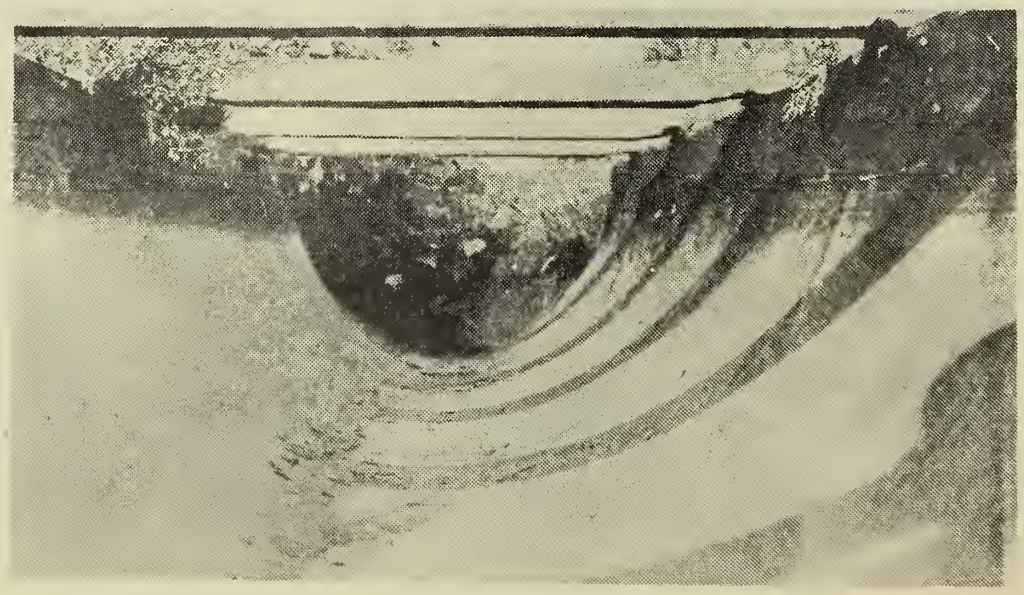
REPAIRING METAL FLUMES

Photograph 26

Photograph courtesy of Bureau of Reclamation, United States Department of the Interior.

View of condition of metal flume prior to repairs, (photograph 26). Numerous holes the size of a hand were in the flume sheets along the transverse points. Several of these holes are indicated in the picture where the fabric lining is exposed. The exposed fabric was colored with white chalk for photographing.

Photograph 27

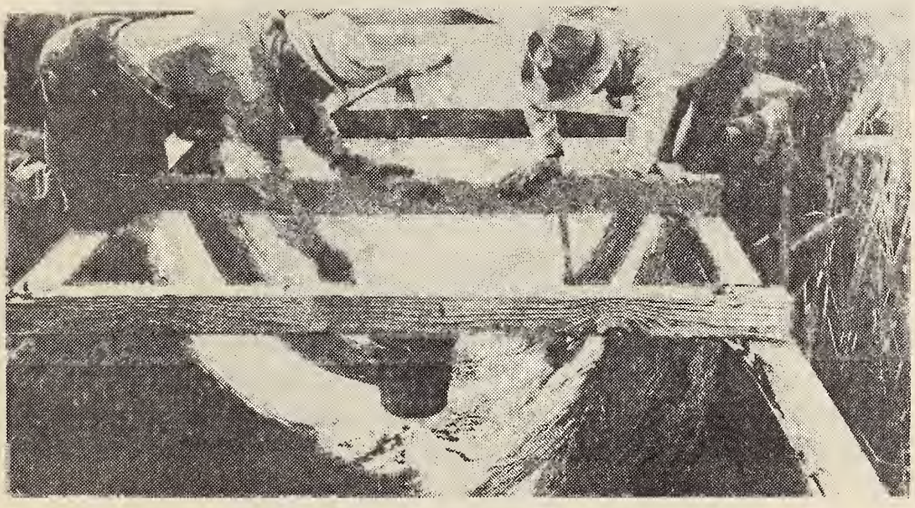


Photograph courtesy of Bureau of Reclamation, United States Department of the Interior.

View showing interior of flume after the repair. An excellent surface for good flowage conditions is apparent, (photograph 27).

In making the repair, three strips of 40-inch fabric were laid over the full length of the flume. This semi-circular flume is 72 inches in size and two of the strips covered the full surface and lapped 8 inches along the bottom. The third strip was centered along the bottom, providing a double thickness along the area in the poorest condition. Fabric containing 40 warp threads and 28 filling threads per inch was used. This type of fabric is shown in photograph 19.

Photograph 28

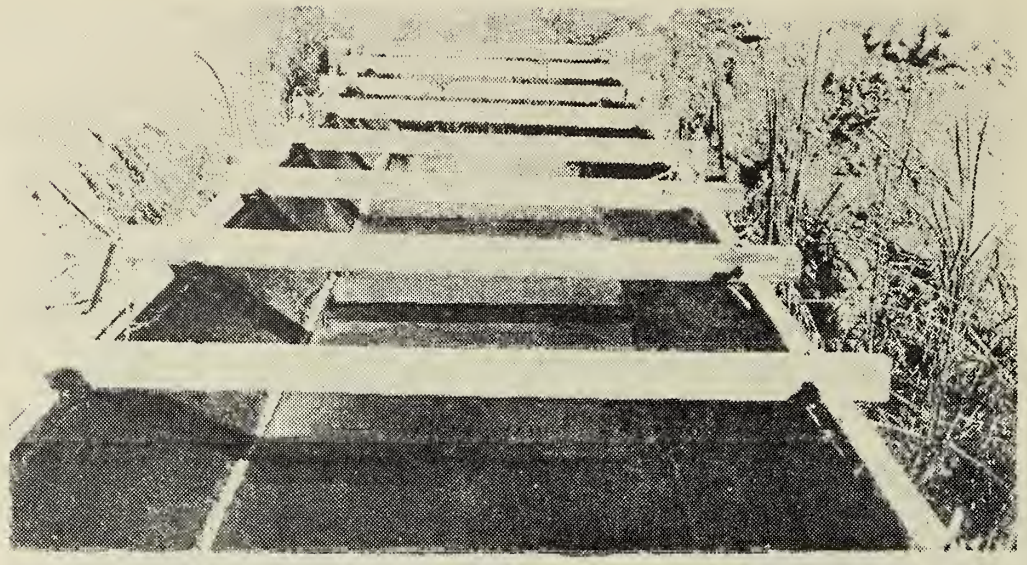


Photograph courtesy of Bureau of Reclamation, United States Department of the Interior.

View showing method of applying fabric to another flume, (photograph 28).

In making flume repairs, a coat of hot asphalt is applied to the metal surface of the flume and the fabric immediately applied. Another coat of hot asphalt is then applied over the fabric. This process is repeated until the desired number of layers are placed. Weak places in the metal lining can be built up with several layers of small pieces of fabric until sufficient strength is obtained. A preservative treatment of the fabric, prior to laying, is recommended by one cooperating agency.

Photograph 29



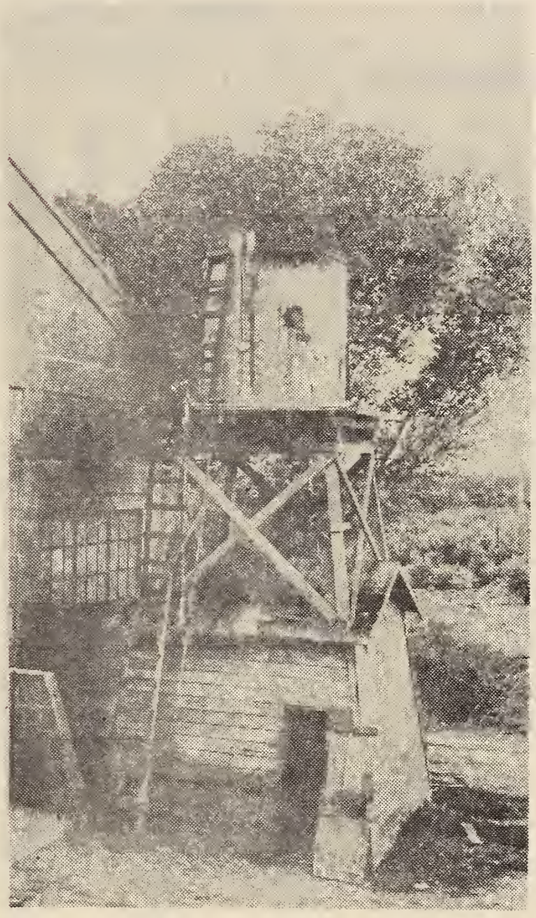
Photograph courtesy of Bureau of Reclamation, United States Department of the Interior.

View showing repair in which the dead water pooled in the flume indicates the water tightness of the work, (photograph 29). While it is not suggested that fabric can be substituted for metal sheets, it is believed that cotton can be used to advantage during periods of financial stress and in repairing old flumes in which the supporting structure is in poor alignment.

The flexibility of the cotton fabric, the economy of the repair, and the rapidity with which it can be done, gives cotton a definite place in keeping flumes in good repair.

REPAIRING WATER STORAGE TANK

Photograph 30



Photograph courtesy of Bureau of Reclamation, United States Department of the Interior.

Photograph 30 shows a storage tank repaired with cotton fabric.

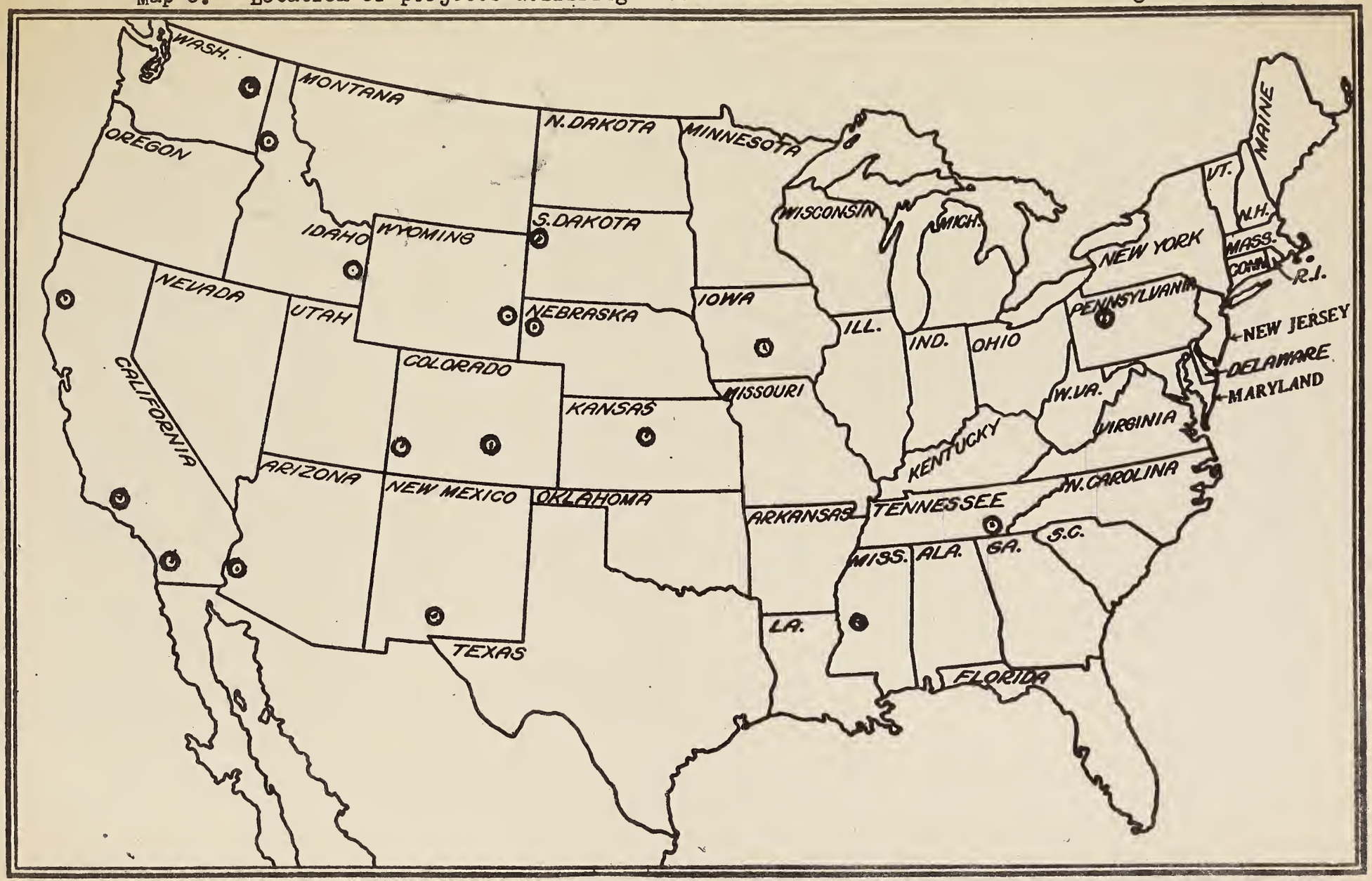
This storage tank was in such a deteriorated condition, immediate replacement was thought necessary. A treatment of the 40 x 28 fabric and asphalt made a repair which it is thought will extend the life of the tank ten years. The cost of the repair was approximately $10.00.

Table 8. - Agencies cooperating in the use of cotton fabric for ditch and canal linings.

Name of cooperating agency and where used	Type fabric supplied			Approximate quantity fabric supplied (square yard equivalent)
	Warp	Filling	Width (inches)	
United States Soil Conservation Service:				
Conway, Arkansas	9	9	40	1,159
Conway, Arkansas	17	5	40	1,667
Santa Paula, California	9	9	82	5,054
Santa Paula, California	12	12	82	5,141
Des Moines, Iowa	17	5	40	2,222
Canton, Mississippi	17	5	40	12,511
Albuquerque, New Mexico	9	9	40	222
Spartanburg, South Carolina	9	9	74	2,056
Spokane, Washington	17	5	40	8,889
Spokane, Washington	80	80	39	2,049
United States Bureau of Reclamation:				
Yuma, Arizona	40	28	40	6,014
Orland, California	40	28	40	5,869
Montrose, Colorado	40	28	40	5,867
Ballantine, Montana	40	28	40	5,981
Mitchell, Nebraska	40	28	40	8,870
Newell, South Dakota	40	28	40	5,820
El Paso, Texas	40	28	40	5,832
United States Bureau of Agricultural Engineering:				
Soda Springs, Idaho	9	9	82	23,010
United States Bureau of Plant Industry:				
Yuma, Arizona	9	9	74	637
United States Navy Department, Bureau of Yards and Docks:				
San Diego, California	9	9	82	1,266
Office of Indian Affairs, United States Department of the Interior:				
Kaw, Oklahoma	7	7	90	3,000
Goshen Irrigation District:				
Torrington, Wyoming	9	9	90	12,720
Tennessee Valley Authority:				
Turtletown, Tennessee	1/	1/	1/	1,600
Total fabric supplied				127,456

1/ Fabric having the following minimum specifications was supplied to the Tennessee Valley Authority for use in the curing of concrete in dam construction at Turtletown, Tennessee: Weave: Three leaf twill, four leaf twill, or broken twill; Thread count: Not less than 120 threads per square inch in combination warp and filling of which the filling threads constitute not less than 38 threads per inch; Width: 60 inches or greater; Weight: 12.0 ounces per square yard; Sizing: Not more than 10 percent; Minimum breaking strength: Warp: 100 pounds; Filling: 50 pounds.

Map 3. - Location of projects utilizing cotton fabric for ditch and canal linings.



◎ Indicates location of one or more projects.

CUTS AND FILLS

There are over 3 million miles of public roads in the United States. These roads necessarily cut the terrain at all angles and divert water run-off from its natural flow. As a consequence, where proper protection is not provided, deep gullies are formed on the side banks of, and parallel to, the highway, adjacent agricultural lands are frequently eroded, and many of the roads are so severely damaged by erosion they require frequent repair.

Those agencies charged with road building and road maintenance are presented with serious problems occasioned by the washing, sliding, and crawling of soil on the slopes of road cuts and fills.

One of the current methods of meeting these erosion problems consists of the following four steps:

1. Provide for road surface drainage:

2. Prepare side slopes by smoothing existing gullies or otherwise:

3. Sow cereal grains or other quick growing annuals to provide as quickly as possible for soil binding through development of the fibrous roots of such temporary vegetation; and

4. Plant suitable shrubs or trees to establish a complete self-perpetuating cover of vegetation to hold the soil.

Cotton fabric is being tried to prevent the movement of soil on such slopes between the time of sowing of grain or grasses and the time such grains or grasses have developed sufficient root to form a mat cover to hold the soil in place.

Photographs 31 to 36, inclusive, were taken at various stages of a project of the Pennsylvania Department of Highways featuring the use of cotton fabric on cuts and fills of Route 641 in Beaver County, Pennsylvania.

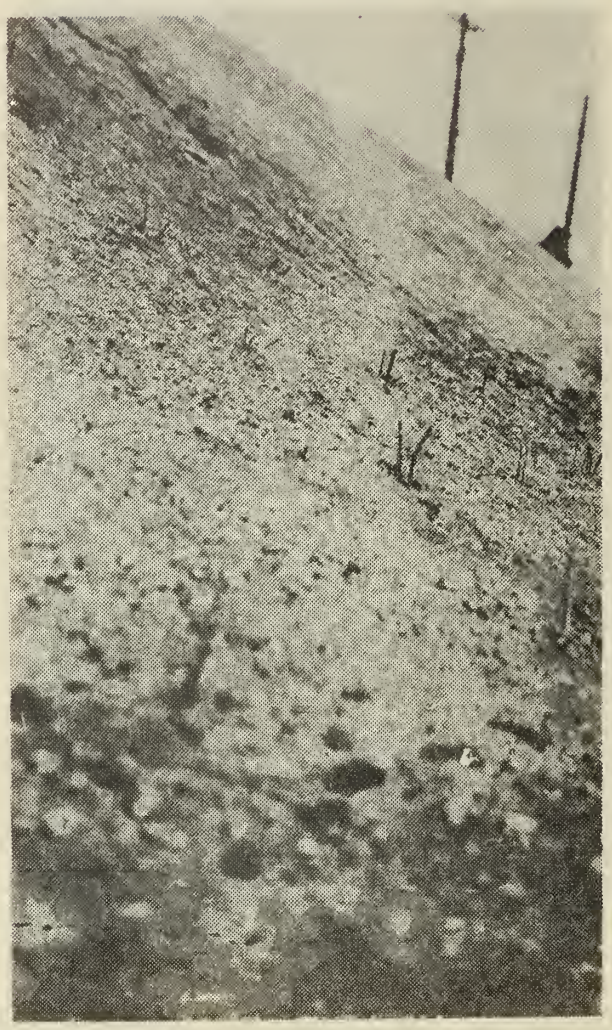
Photograph 31

Photograph courtesy of Pennsylvania Department of Highways.

Close-up of original soil condition showing soil consisting of 25 percent gravel, 60 percent sand, and the balance loam and clay, (photograph 31). A soil condition such as this is subject not only to erosion from water but also to wind erosion. These factors made it practically impossible to establish an immediate vegetative covering without the aid of suitable cotton fabric.

Slope after grading, planting and seeding, (photograph 32). Slope was graded back to 1-1/2:1. From two to three inches of clay top soil was added before seeding. Locust was used at many points in addition to slope grass.

Photograph 32



Photograph courtesy of Pennsylvania Department of Highways.

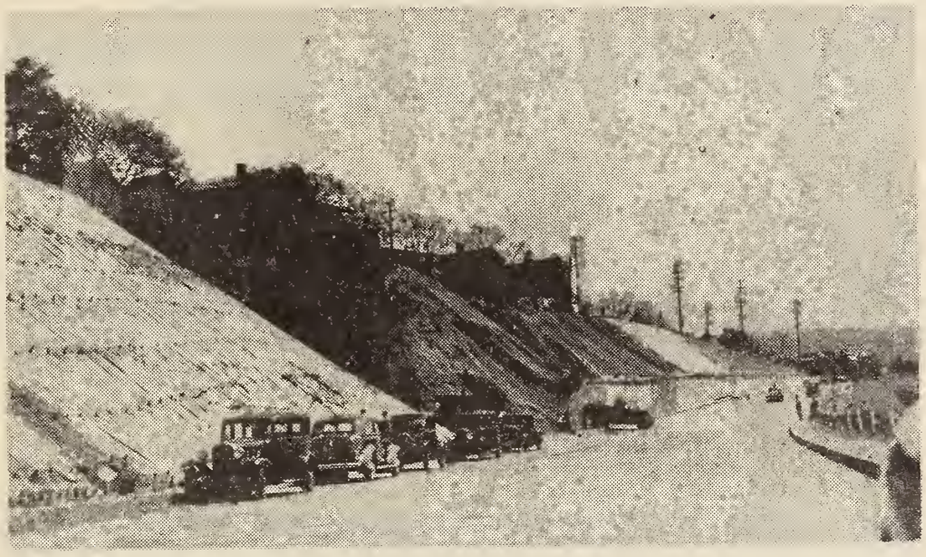
Photograph 33

Photograph courtesy of Pennsylvania Department of Highways.

Photograph 33 shows cotton fabric in place on a side slope of Route 641, Beaver County, Pennsylvania. Note that cotton fabric is placed vertically and that stakes are used to hold fabric in place. Other cooperating agencies used wire pegs, spaced three feet apart, for the same purpose. It is recommended that fabric be completely lapped along the edges.

In the center of the photograph may be seen a stone spillway which was constructed for the purpose of concentrating excessive storm water. This entire structure was washed away during a cloudburst approximately two months after it was completed. The slope area covered with cotton fabric, however, experienced no material damage.

Photograph 34



Photograph courtesy of Pennsylvania Department of Highways.

View showing various stages of slope treatment, (photograph 34). Note growth of grass through fabric on left slope. Slope in center being prepared and graded but to which no cotton fabric has been applied. White strip in rear shows slope where cotton fabric had just been applied.

Photograph 35

Photograph courtesy of Pennsylvania Department of Highways.

View of same slope shown in photograph 33 four months later. Note that stone spillway, shown in photograph 33, has been eliminated, following the cloudburst when the structure was washed away. Surface water is now concentrated into secondary ditches and brought down along both ends of the slope, (photograph 35).

Methods of ground preparation and application of fabric:

Ground slopes: Reports received from cooperating agencies indicate that fabric has been applied on slopes ranging from 1:1 to 1:4. Best results have been obtained, however, on slopes of 1-1/2:1 or flatter.

Soil preparation: It is recommended that the soil be carefully prepared prior to seeding. Several of the cooperating agencies practiced fertilization, others added top soil to the slopes.

Seed application: The type of seed used varied with the climatic and soil conditions prevailing in the different areas. In general, the practice followed was to sow fibrous, erosion-resistant grasses or legumes along with quick-growing annuals, such as cereal grains, to act as nurse crops. Shrubs and trees were also planted by some cooperating agencies.

Fabric application: Two practices were followed by cooperating agencies in applying the fabric--one was to apply the fabric alone over the prepared slope, the other was to apply the fabric over a mulch of straw, hay, or leaf mold.

Fabric applied alone yielded satisfactory results on slopes 1-1/2:1 or flatter. Indicative of this are the results reported pictorially above.

Where a mulch was used along with the fabric, several agencies reported fabric to be of definite value on slopes as steep as 1:1.

It is recommended that fabric be laid vertically and that it be securely staked to the slope. Either wire pegs or wood stakes may be used for this purpose. The pegs should be so spaced as to insure a complete lap of the fabric along the edges.

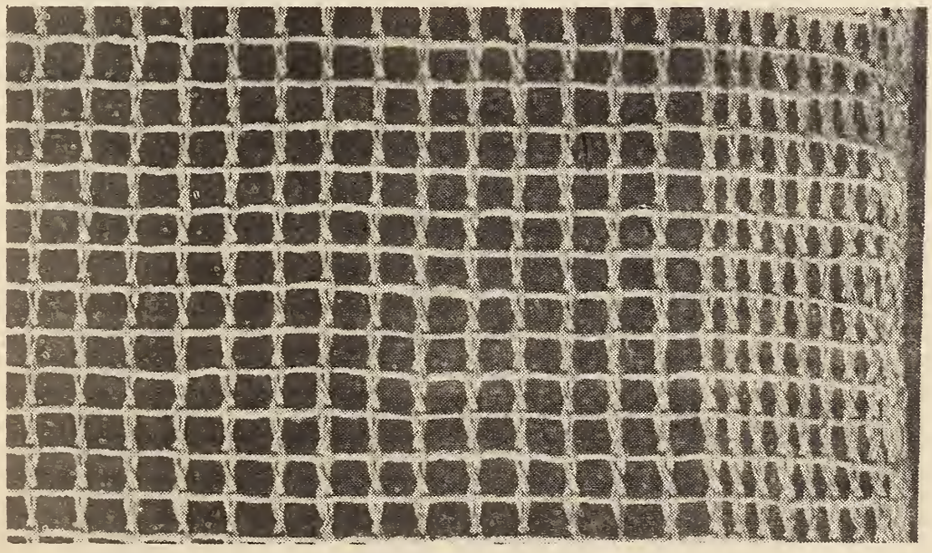
One of the cooperating agencies, using cotton fabric alone, reported excellent results from the use of three or four strips of cotton fabric, pinned together and placed along the slopes with stakes at the tops and bottoms of the strips.

Some agencies allow the fabric to remain on the slope until it deteriorates. Others, have the fabric taken up as soon as the vegetation becomes established and then use the fabric on other slopes.

Type of fabric supplied:

Following is a photograph of the type of fabric supplied to cooperating agencies, for use as a covering or membrane for erosion control in connection with fills or cuts on roads or highways or in connection with other fills or cuts:

Photograph 36



Photograph by Marketing Section, United States Department of Agriculture.

Actual scale photograph of 17 ($4\frac{1}{4} \times 4$) by 5 fabric, (photograph 36).

Specifications:

Yarns:
Warp: Single.
Filling: 4-ply.

Weave: Leno with 2 warp ends working as one.

Width: 40 inches (48 inches in one case).

Thread count:
Warp: 17 threads per inch ($4\frac{1}{4} \times 4$).
Filling: 5 threads per inch.

Weight: 3.55 ounces per yard, 40 inches wide.

Selvage: 34 ends one inch wide each side, leno weave.

Average breaking strength (grab method):
Warp: 35 pounds.
Filling: 20 pounds.

Small tolerances from these specifications were permitted.

Cooperating agencies:

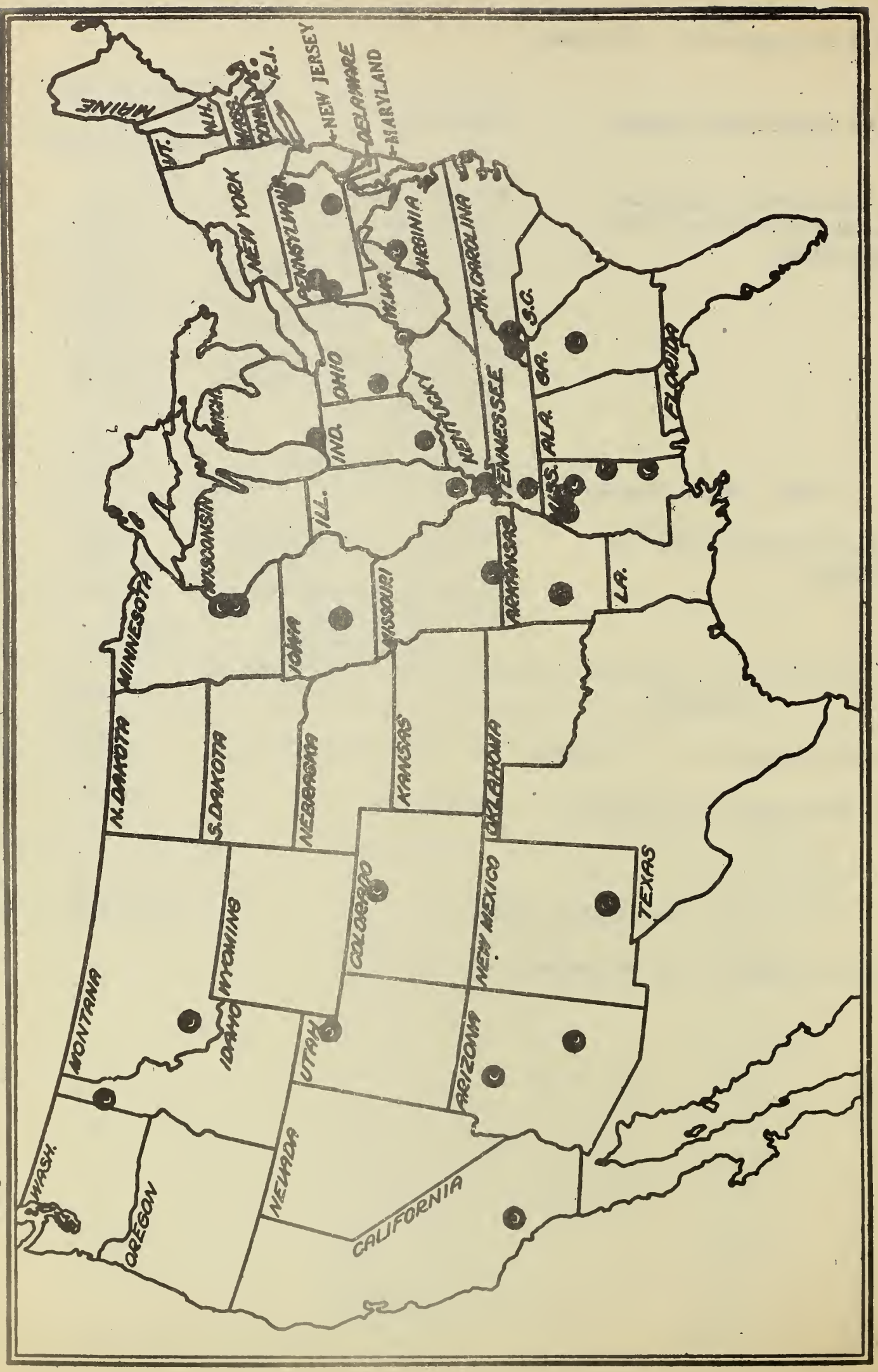
Name of cooperating agency	Where used	Approximate quantity of fabric supplied Square yard equivalent
Forest Service, United States Department of Agriculture	Globe, Arizona	1,111
	Hot Springs, Arkansas	1,111
	Glendale, California	3,333
	Fort Collins, Colorado	222
	Harrisburg, Illinois	1,111
	Bedford, Indiana	11,111
	St. Paul, Minnesota	2,222
	Holly Springs, Mississippi	2,222
	Willow Springs, Missouri	11,111
	Alder, Montana	289
	Cloudcroft, New Mexico	1,111
	Franklin, North Carolina	2,222
	Otto, North Carolina	2,222
	Pedro, Ohio	8,889
	Ogden, Utah	1,111
	Flagstaff, Utah	1,111
	Bridgewater, Virginia	6,667
Total fabric supplied to Forest Service		57,176

Cooperating agencies - continued.

Name of cooperating agency	Where used	Approximate quantity of fabric supplied Square yard equivalent
Soil Conservation Service United States Department of Agriculture	Worley, Idaho	11,111
	Des Moines, Iowa	1,111
	Paducah, Kentucky	2,222
	Benton Harbor, Michigan	1,111
	Ecru, Mississippi	2,200
	Senatobia, Mississippi	39,556
	Shuqualak, Mississippi	5,800
	Waynesboro, Mississippi	2,511
	Dayton, Ohio	2,778
	Mt. Vernon, Ohio	1,111
	Jackson, Tennessee	5,556
Total fabric supplied to Soil Conservation Service		75,067
Pennsylvania Department of Highways	Franklin, Pennsylvania	33,336
	Harrisburg, Pennsylvania	11,132
	Scranton, Pennsylvania	11,119
	West Bridgewater, Pennsylvania	11,122
Total fabric supplied to Pennsylvania Department of Highways		66,709
Minnesota Department of Highways	St. Paul ,Minnesota 1/	6,453
D. C. Department of Highways	Washington, D. C.	12,200
Total fabric supplied for use		217,605

1/ Fabric supplied was 48 inches wide.

Map 4. - Location of projects utilizing cotton fabric for cuts and fills.



● Indicates location of one or more projects.

COTTON FOR ROADS, STREETS AND AIRPORT RUNWAYS

There are about 2,000,000 miles of unimproved roads in the United States. Bituminous materials are among those most commonly used for road improvement where first costs of concrete are too high. Approximately 20,000 miles of bituminous-surfaced roads are constructed and about 45,000 miles of such roads are repaired in the United States each year. The immensity of these figures suggested the tremendous potential market for cotton which might be developed through the use of this fabric as a binder in such roads and plans were made to investigate the possibilities by establishing experimental road-building projects, to supplement similar tests carried on in South Carolina in 1926. Trial use of cotton fabric was also carried on for city streets and airport runways.

Cotton mats for curing concrete roads were developed by the Bureau of Public Roads and the Texas State Highway Department. These mats were designed to replace the usual methods of curing concrete, including ponding, wet earth, hay, straw, and burlap. A program for trial use of cotton mats under widely varying conditions was also sponsored.

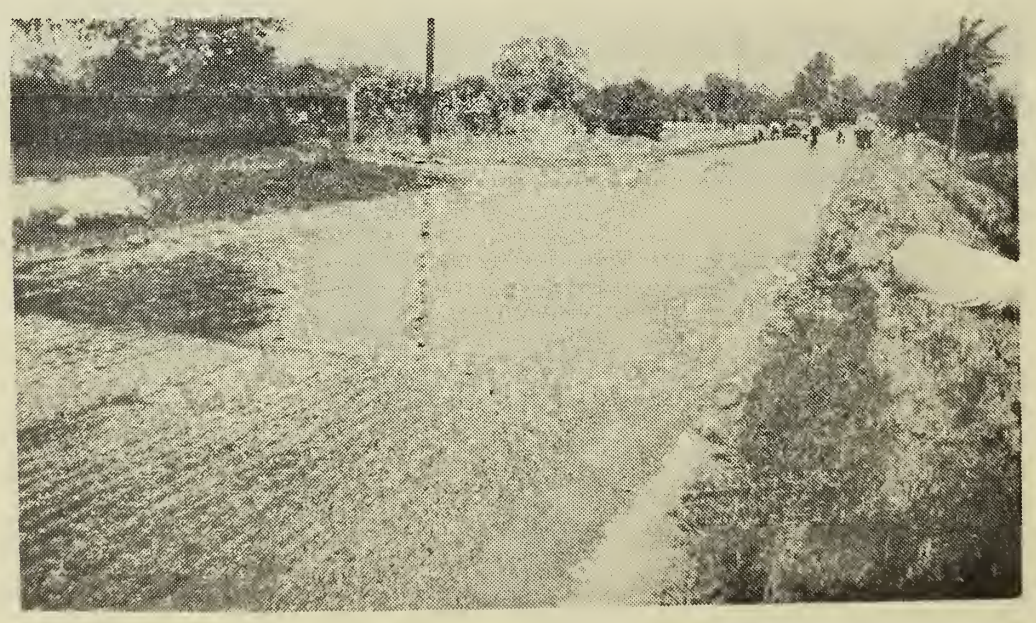
Reinforcing for roads:

Experimental work to determine the value of cotton fabric as a reinforcing membrane in the construction of thin bituminous-treated roads was started in South Carolina in 1926. Results derived from eight experimental projects constructed in that state indicated that the use of cotton fabric as a reinforcement in thin bituminous surface-treatment appeared to prolong the life of the roads by reducing cracking, raveling, and failure.

Although these experiments yielded promising results, they were not conclusive in answering questions as to where and under what conditions it might be practicable to use cotton fabric in the construction of such roads. To test cotton reinforcement under varying climatic conditions, therefore, the equivalent of more than 6,000,000 square yards of fabric, sufficient for about 578 miles of 18-foot roads, was made available in 1936 by the United States Department of Agriculture to cooperating agencies located in 24 states.

Photographs 37 to 46, taken at various projects, show the method of application and use of cotton fabric as a reinforcing for bituminous surfaced roads.

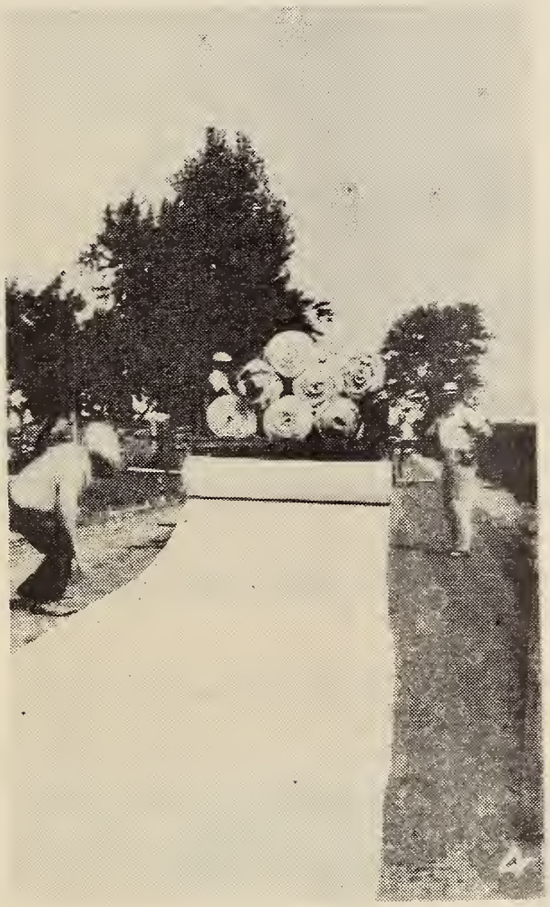
Photograph 37



Photograph by the Marketing Section, Agricultural Adjustment Administration, United States Department of Agriculture.

Use of cotton fabric on Route 260, between Routes 18 and 31, about 20 miles west of Rochester, New York, (photograph 37). Note scraped surface of old road in the foreground, and the coat of hot tar over the old road in the mid-section. In the background can be seen a crew of men laying the cotton fabric over the hot tar. On the sides can be seen two rolls of cotton fabric.

Photograph 38

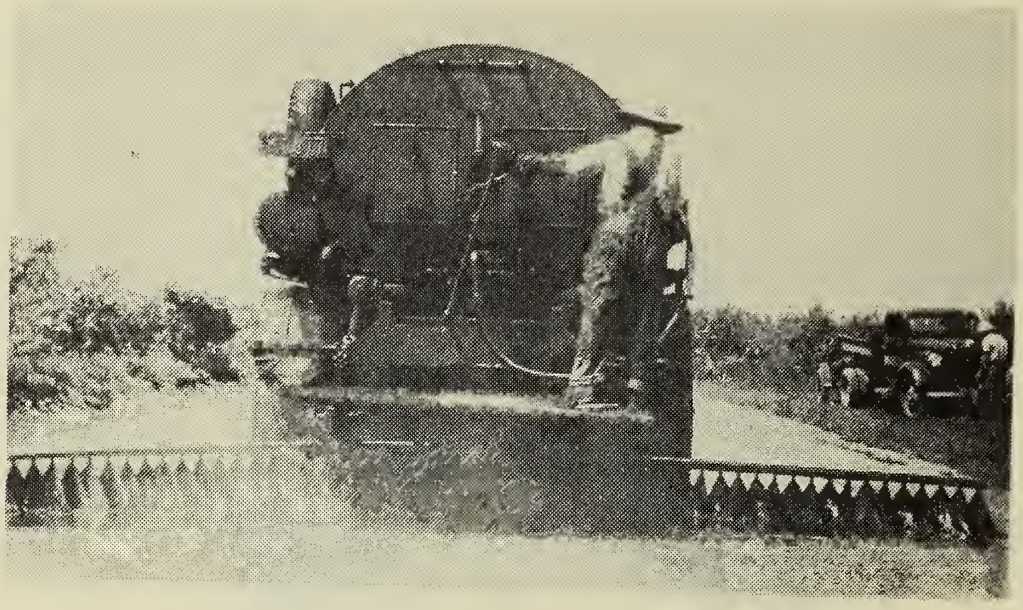


Photograph courtesy of New Jersey
Highway Department.

View showing cotton fabric being unrolled from rear of truck on Perkintown Road, Salem County, New Jersey, (photograph 38). Note simple chain attachment by which the roll of fabric is held, permitting the speedy and efficient unrolling and laying of the cotton.

Prior to unrolling the fabric, the road base is primed with bituminous material. The fabric is then spread longitudinally in overlapping strips covering the full width of the primed surface. The general practice is to spread the fabric while the prime is still sticky enough to hold it in place.

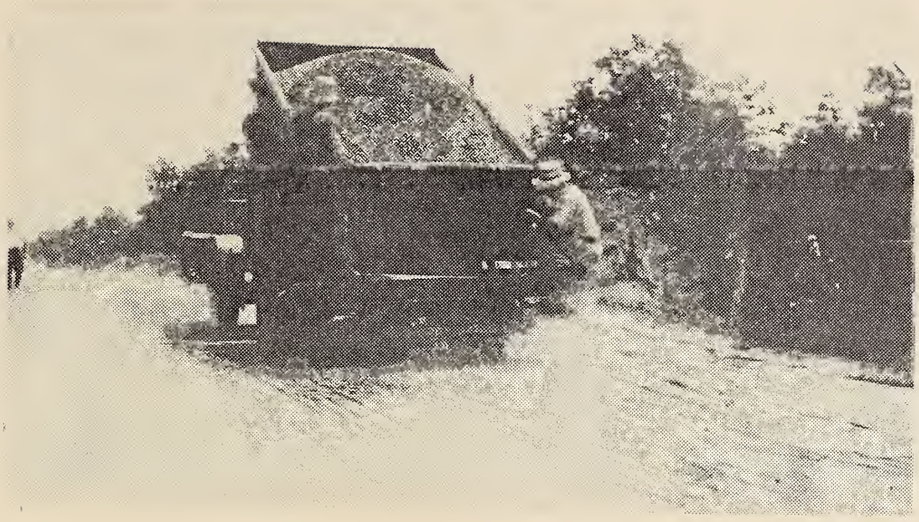
Photograph 39



Photograph courtesy of New Jersey Highway Department.

Distributor truck applying tar across full width of road directly on top of the three strips of reinforcing cotton fabric membrane, Glassboro-Cross Keys Road, Gloucester County, New Jersey, (photograph 39). The practice is sometimes followed of making the application on only one half of the width, thus leaving the road open to traffic during operations,. This is the second application of bituminous material, the first having been the prime coat applied just prior to the laying of the fabric.

Photograph 40



Photograph courtesy of New Jersey Highway Department.

View showing distribution of stone screenings immediately on top of tar application, Glassboro-Cross Keys Road, Gloucester County, New Jersey, (photograph 40). Other types of aggregate may be used efficiently. Sand applied at the rate of about 45 pounds per square yard, has also been found satisfactory.

Photograph 41

Photograph courtesy of New Jersey Highway Department.

Rolling the surface, Glassboro-Cross Keys Road, Gloucester County, New Jersey, (photograph 41). Final step in the construction of a bituminous-surfaced road. Where sand is used, the surface is dragged with a wire link drag which serves to level out irregularities in the sanded surface and gives the road a more uniform appearance.

Method of application:

Base preparation: The cotton fabric should be used as a reinforcement for thin bituminous surface treatments on previously consolidated bases of adequate thickness. The bases may be of the stabilized soil types such as sand-clay top-soil, or sand-clay-gravel, or water-bound macadam, or other types of base suitable for surface treatment. When the fabric is used on a new road, a bituminous and aggregate base takes the place of the old road bed. Surfaces of old roads are scraped prior to treatment.

Prime coat: The base is first primed with bituminous material. This application may vary from 1/3 to 1/2 gallon per square yard. No special type of material is recommended although best results have been obtained from the use of the heavier tars and asphalts.

Laying the fabric: The fabric may be laid by hand or may be unrolled from a truck. The latter method is, of course, considerably faster and more efficient. The general practice is to spread the fabric while the prime is still sticky enough to hold it in place. This practice is advantageous in securing some impregnation of the fabric with the thin bituminous priming material. If the fabric is laid after the prime coat has dried, the fabric must be pinned, weighted, or sealed down so that it will not be disturbed by the subsequent construction operations. The fabric is spread longitudinally in overlapping strips covering the full width of the primed surface.

Surface treatment: As soon as the prime has cured sufficiently, the surface treatment, consisting of one or more applications of bituminous material and crushed mineral aggregate, is constructed. Crushed aggregate material is sometimes spread over the cotton fabric, at the rate of 5 to 10 pounds per square yard, just prior to the construction of the surface treatment, in order to protect the fabric from damage by the wheels of the distributor. The quantity of bituminous material reported used by cooperating agencies in the surface treatment ranged from about 0.4 to 0.78 gallons per square yard. Aggregate was reported spread at the rate of from 25 to 50 pounds per square yard, sand at from 35 to 45 pounds per square yard.

Following the application of the aggregate, the surface is rolled smooth. Where sand is used, the surface may be dragged or rolled.

The above treatment is not presented as the only satisfactory method of constructing cotton-reinforced bituminous-surfaced roads. Other methods may be successfully used except that a procedure which involves mixing the bituminous material and aggregate on the road surface would not be suitable since the fabric would be likely to be displaced and damaged by the mixing operations.

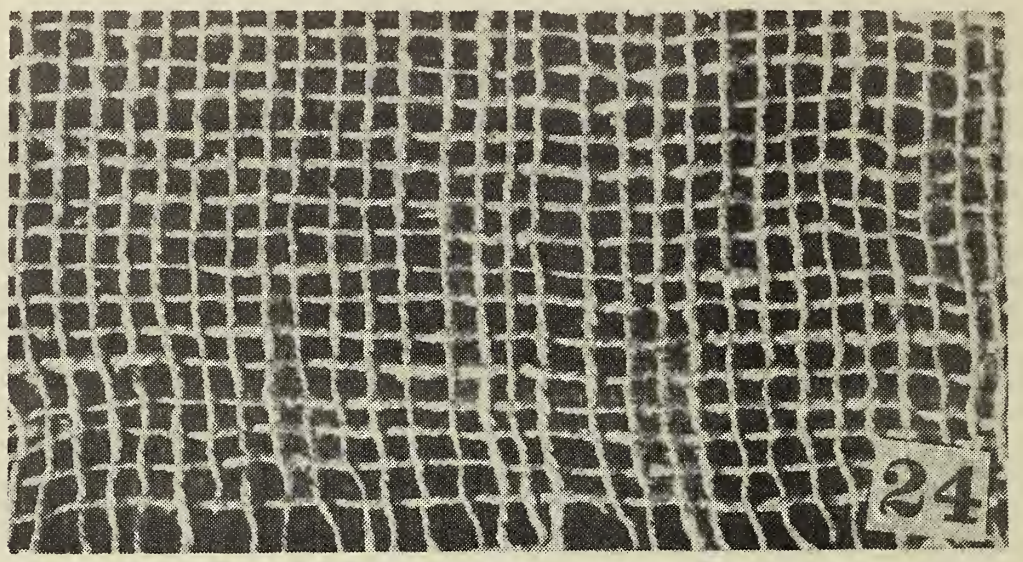
Types of fabric supplied:

Three types of fabric, each manufactured in three widths, were supplied to cooperating agencies for use as membrane reinforcements in bituminous surface treatments. These fabrics are of plain weave and made from two-ply yarn given a balanced twist. No sizing is applied to the yarn or to the fabric. Minimum specifications follow:

Thread count per inch		Width	Weight per square yard	Minimum average breaking strength (grab method)	
Warp	Filling			Warp	Filling
		inches	ounces	pounds	
12	12	90	5.30	45	45
12	12	82	5.30	45	45
12	12	74	5.30	45	45
9	9	90	4.25	35	35
9	9	82	4.25	35	35
9	9	74	4.25	35	35
7	7	90	3.20	25	25
7	7	82	3.20	25	25
7	7	74	3.20	25	25

Actual scale photographs of the three types of fabric are shown below:

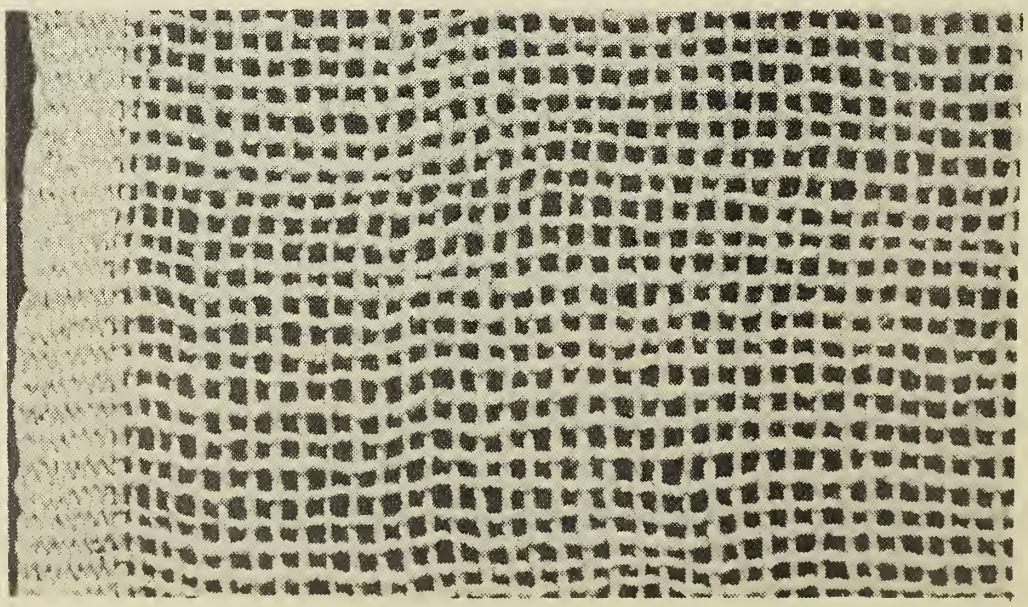
Photograph 42



Photograph by Marketing Section, Agricultural Adjustment Administration, United States Department of Agriculture.

Actual scale photograph of 7 x 7 fabric, (photograph 42).

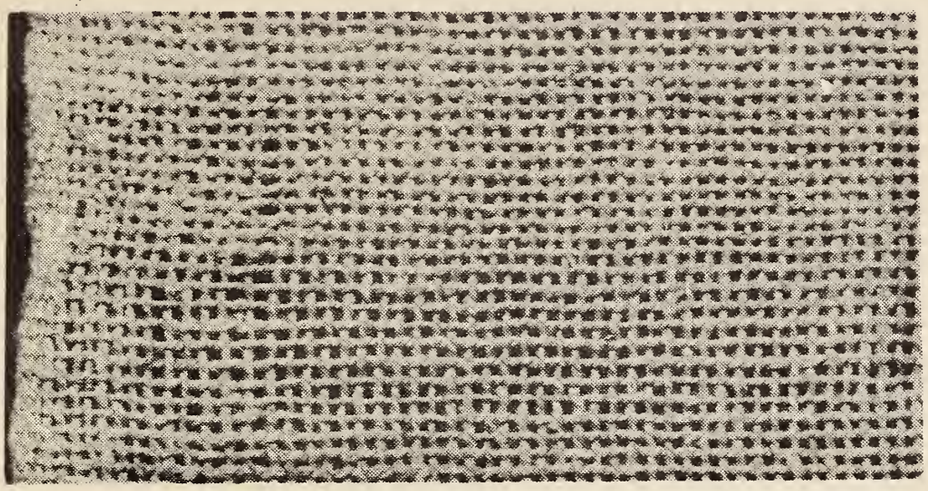
Photograph 43



Photograph by Marketing Section, Agricultural Adjustment Administration, United States Department of Agriculture.

Actual scale photograph of 9 x 9 fabric, (photograph 43).

Photograph 44



Photograph by Marketing Section, United States Department of Agriculture.

Actual scale photograph of 12 x 12 fabric, (photograph 44).

Cooperating agencies:

Under provisions of the cotton roads program, fabric was made available only to state highway commissions, departments, or bureaus. The following table lists the quantity of road fabric supplied to states under the cotton-for-roads program for reinforcing thin bituminous surfaces.

State	Quantity		
	Linear Yards	Square yard equivalent	Miles 18-foot Road
Alabama	553,212	1,260,094	119.33
Arkansas	54,000	123,000	11.65
Arizona	73,287	171,952	16.28
California	26,400	66,000	6.25
Florida	23,760	54,120	5.12
Georgia	63,360	144,320	13.67
Indiana	55,440	113,962	10.79
Maine	10,560	18,187	1.72
Massachusetts	21,120	43,413	4.11
Michigan	179,190	447,975	42.42
Mississippi	48,000	109,333	10.35
Missouri	102,960	257,400	24.38
Montana	15,840	39,600	3.75
Nevada	28,740	66,117	6.26
New Hampshire	10,560	21,707	2.06
New Jersey	45,000	102,500	9.71
New York	528,700	842,122	79.75
North Carolina	517,440	1,115,253	105.61
Oregon	21,000	36,167	3.43
Rhode Island	64,800	125,100	11.84
South Carolina	295,680	669,973	63.44
Tennessee	31,650	72,092	6.83
Virginia	52,800	89,173	8.44
Washington	67,940	117,006	11.08
Total	2,891,439	6,106,566	578.27

Proposed method of using cotton in bituminous road construction:

Recently another method of using cotton in bituminous road construction has been proposed. This method consists of enveloping the entire roadbed in an asphalt impregnated cotton fabric. With some flexibility as to details the suggested procedure for application of the fabric is as follows:

1. Excavate the earth or the roadbed to the proper depth.

2. Shape and compact the bottom and sides of the excavated area.

3. Lay an asphalt impregnated cotton fabric in the bottom of the roadbed and up the sides of the excavated area having the fabric of sufficient width to fold several inches over the top of the earth to be back-filled.

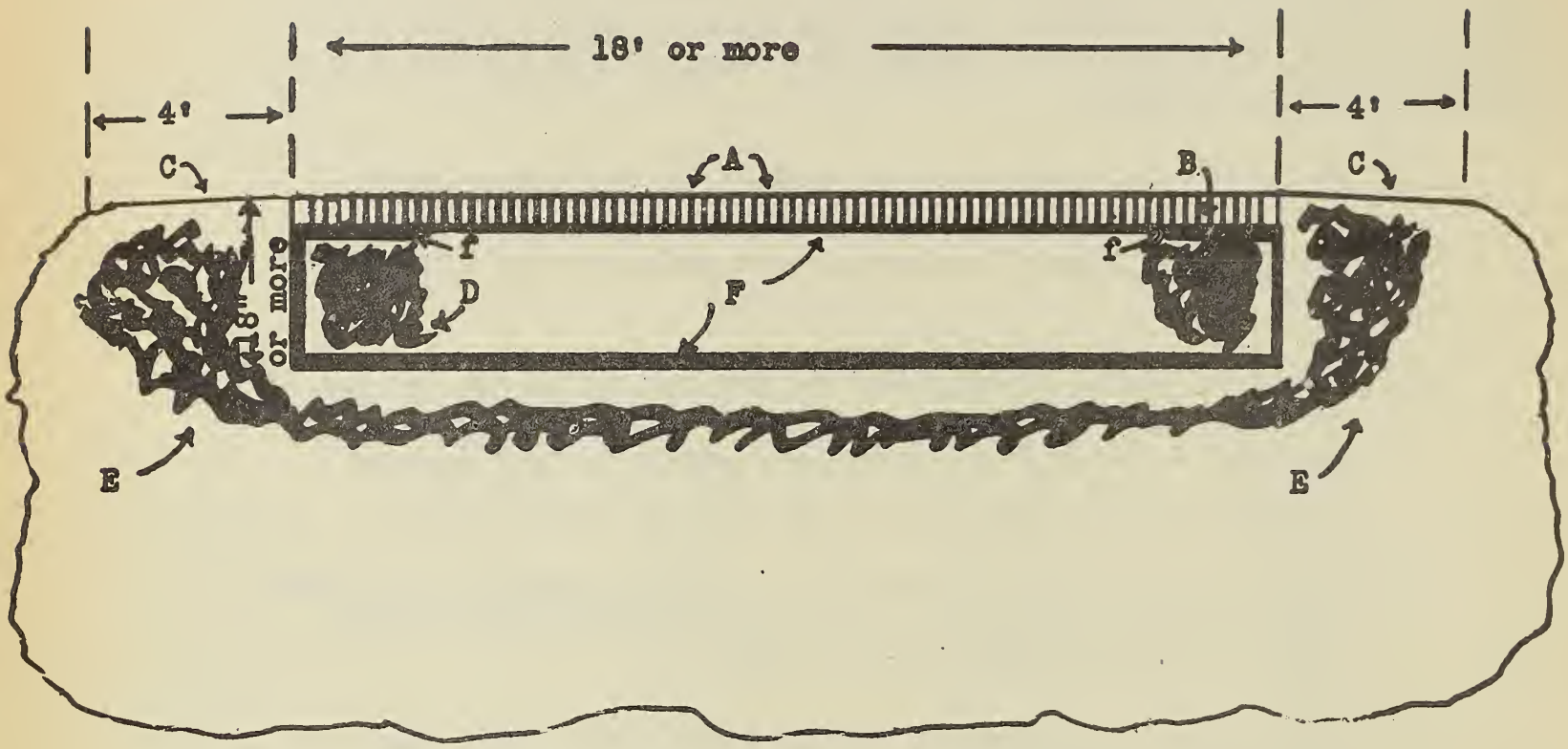
4. Back-fill the earth scooped out of the excavated area and fold the upper edges of the asphalt impregnated cotton fabric over the earth back-filled.

5. Lay asphalt impregnated cotton fabric flat over the full width of the road overlapping the folded flaps of the cotton fabric. This procedure completely envelopes the back-filled earth.

6. Cover the entire mass with asphalt or other material to proper depth to make finished surface of the road.

A cross section of such type of cotton and asphalt road is shown in sketch 5.

Sketch 5.



A - Driving surface (top of road)
B - Road surface consisting of necessary thickness of bituminous and other materials.
C - Shoulder
D - Sub-grade (back-filled material)
E - Earth
F - Cotton fabric impregnated with asphalt or other bituminous compounds.
f - Impregnated cotton fabric folded over the earth back-filled.

Cotton concrete curing mats:

Advantages claimed for cotton curing mats include water absorption capacity, temperature protection, and durability.

Because of the ability of the mats to retain moisture, one wetting per day is sufficient for the curing process. This, of course, reduces labor costs and introduces economy where water is not readily available or is costly to obtain.

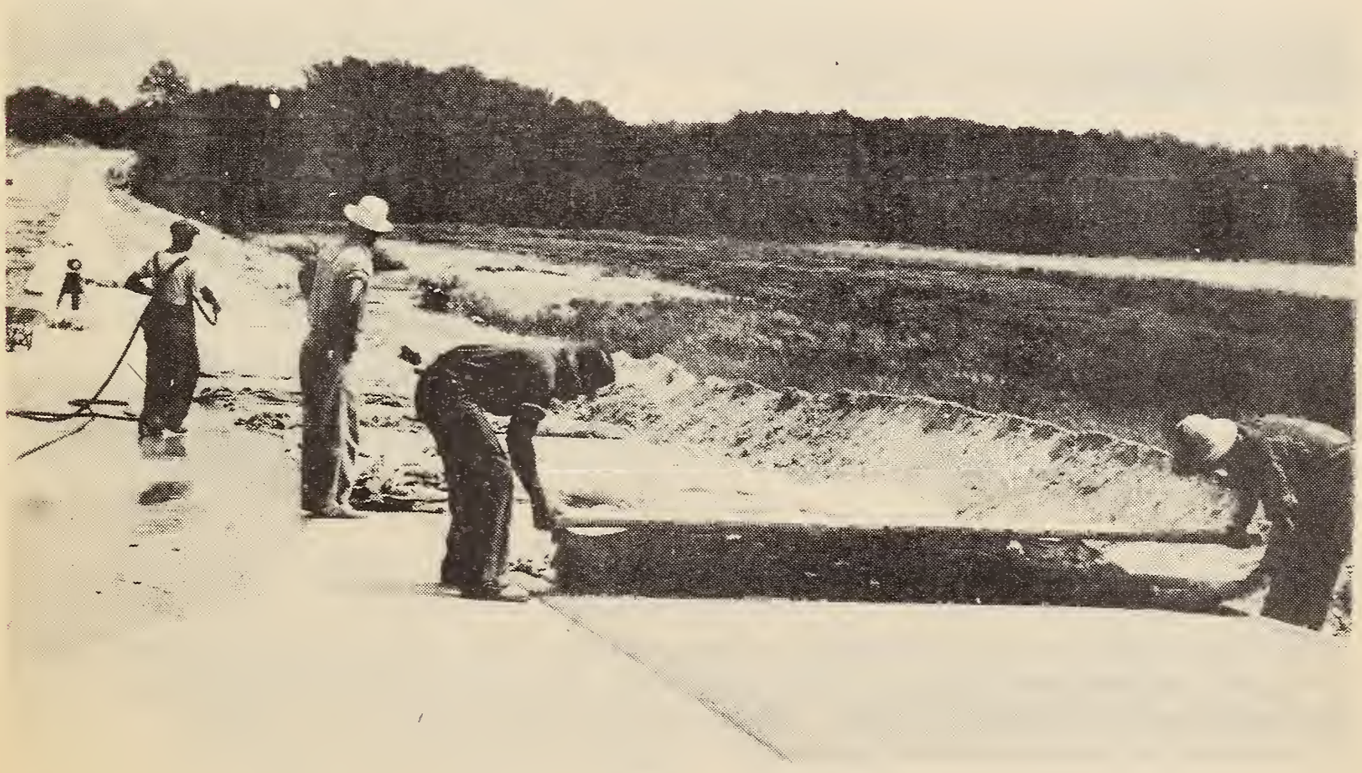
In the curing process, the mats materially lessen the effects of varying air temperatures on the temperature of the curing concrete. They offer considerable protection against freezing and can be used to prevent freezing of the ground prior to the pouring of concrete. Cotton curing mats thereby provide protection for freshly poured concrete from both the frost and the sun.

A cotton curing mat can be used as many as 100 to 150 times. Such durability further reduces the square yard cost of curing concrete.

Experimental results show that concrete cured by the use of mats has a high compression strength.

Photographs 45 and 46 show cotton mats being used in curing concrete highways in Maryland and Texas.

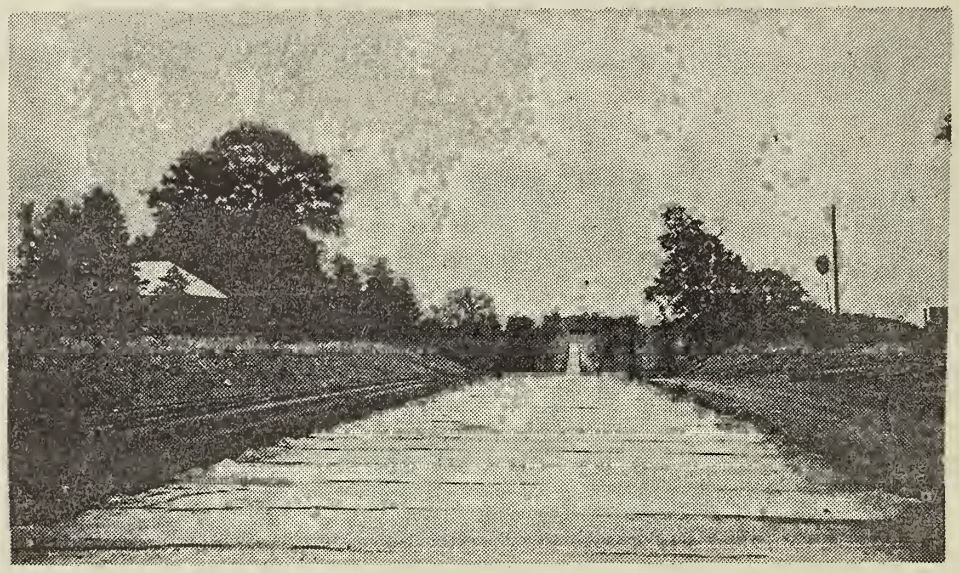
Photograph 45



Photograph courtesy of Bureau of Public Roads, United States Department of Agriculture.

Applying cotton mats in curing concrete highway in the State of Maryland, (photograph 45).

Photograph 46



Photograph courtesy of Bureau of Public Roads, United States Department of Agriculture.

Stretch of new concrete road construction in the State of Texas showing cotton curing mats in place, (photograph 46).

Method of application:

Cotton mats are used for curing concrete pavements in much the same manner that other materials are used for the same purpose. The mats are applied to the surface of the pavement as soon as possible after finishing. They are wet thoroughly before application and kept wet until removal. The curing period requires not less than 72 hours and no further treatment is required subsequently. The flap specified along the edge of the mat insures complete covering of the pavement at the joints between adjacent mats. The mats are laid with the flaps in the direction of progress of the laying of the concrete and each mat is laid on top of the flap of the preceding mat.

Description of mats:

The mats used in the program were filled with bats, weighing 12 ounces per square yard, which were made from low-grade cotton or high-grade waste such as card strips. The covering material of the mats was 7-ounce, 40 inch cotton Osnaburg. A flap 6 inches wide was constructed along one side of each mat by sewing together the covering material without filling. The mats were about 6 feet 3 inches wide

including the 6 inch flap. For pavements 20 feet wide, the mats were made 22 feet 6 inches long to permit them to extend over the edges of the pavement and to allow for shrinkage when the mats were wet. For narrower roads or roads constructed one side at a time, shorter mats are used.

Cooperating agencies:

In 1936 distribution of cotton mats was conducted in the same manner as for cotton road fabric. A total of 89,535 mats were supplied to cooperating agencies located in 23 states. The following table lists the number of cotton concrete curing mats supplied by states:

State	Number of mats	State	Number of mats
Arkansas	1,500	North Carolina	2,755
Arizona	920	Ohio	2,200
California	2,000	Oklahoma	1,500
Georgia	1,000	Oregon	1,000
Illinois	1,870	Pennsylvania	4,500
Indiana	1,500	Rhode Island	6,000
Michigan	2,400	South Carolina	1,200
Minnesota	4,200	Texas	20,000
Mississippi	2,100	Washington	420
Missouri	4,200	West Virginia	900
Nevada	1,250	Wisconsin	720
New York	1/25,400		
		Total supplied	89,535

1/ Not all mats of standard size, about 40 percent being of half size for special type work.

Cotton for streets and airport runways:

The same engineering principle that is involved in the use of cotton fabric in road construction also applies in its use in constructing bituminous surfaced streets and bituminous surfaced airport runways.

Aviation experts prefer asphalt for runways because of its yielding surface. A drawback to its use, however, has been that asphalt might tear under the breaking and turning of heavy ships. It is believed that the use of cotton fabric in conjunction with asphalt may eliminate this difficulty. Projects featuring the use of cotton fabric in conjunction with asphalt for airport runways are, therefore, being closely watched and carefully studied by airport engineers.

Types of fabric supplied 1/

1) Street paving projects

a) 7 x 7 fabric, 74 inches wide
7 x 7 fabric, 90 inches wide

b) 9 x 9 fabric, 74 inches wide
9 x 9 fabric, 82 inches wide
9 x 9 fabric, 90 inches wide

c) 12 x 12 fabric, 74 inches wide
12 x 12 fabric, 90 inches wide

2) Airport runways

a) 9 x 9 fabric, 74 inches wide

b) 12 x 12 fabric, 90 inches wide

1/ Views of these fabrics are shown in photographs 42, 43, and 44.

Cooperating agencies.

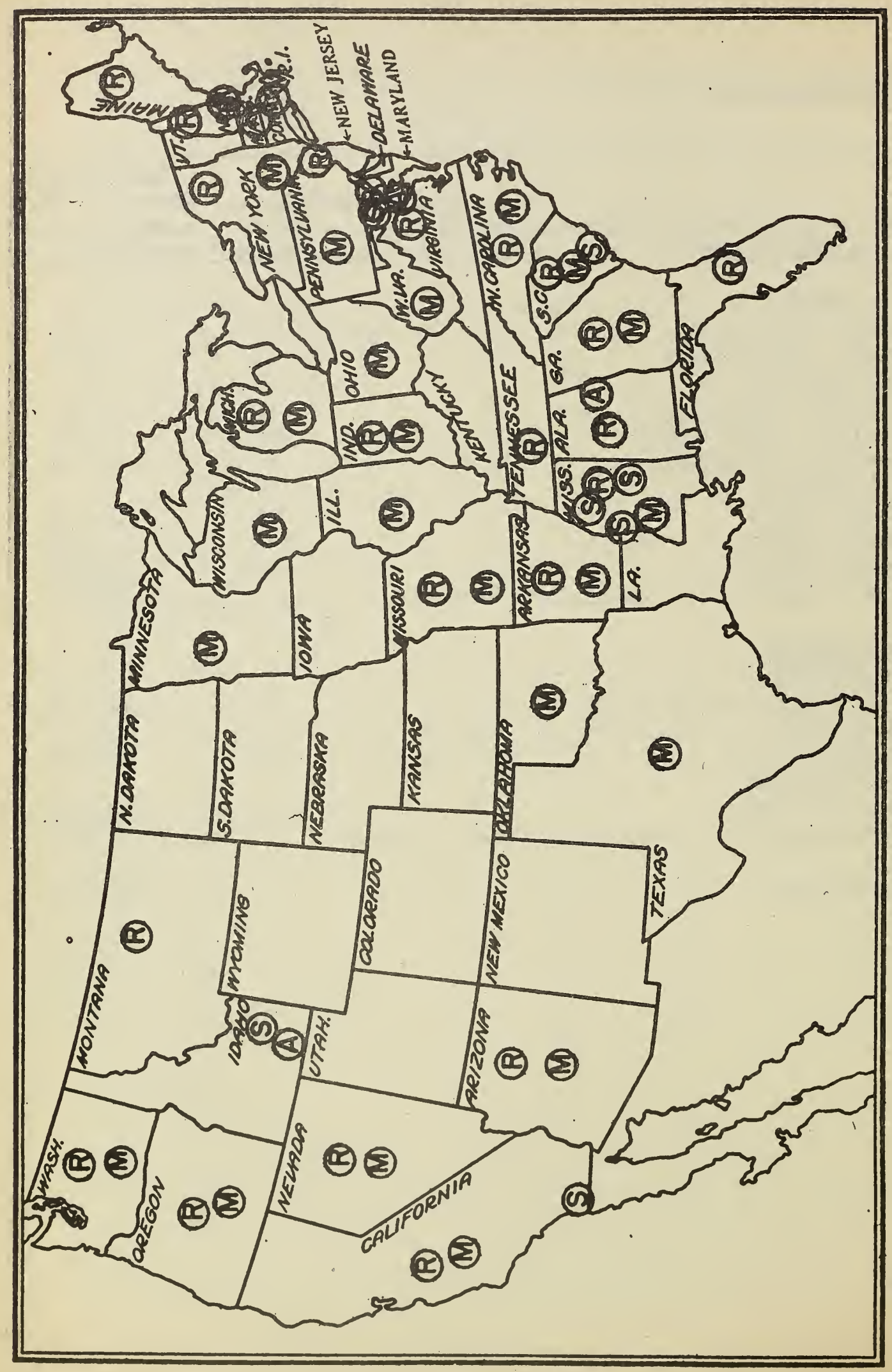
Name of cooperating agency and where used	Type of fabric: Thread count: Warp	Filling	Width (inches)	Approximate quantity fabric supplied (square yard equivalent)
Street paving projects				
Navy Department				
Mare Island, California	12	12	90	20,265
Portsmouth, N. H.	12	12	90	4,410
San Diego, California	12	12	90	2,102
Annapolis, Maryland	9	9	90	2,284
Charleston, South Carolina	7	7	90	988
Charleston, South Carolina	9	9	82	1,030
Charleston, South Carolina	12	12	74	1,032
City of Greenville				
Greenville, Mississippi	12	12	90	43,888
D. C. Department of Highways				
Washington, D. C.	9	9	74	10,407

Cooperating agencies (cont'd)

Name of cooperating agency and where used	Type of fabric: Thread count: Warp	Filling	Width (inches)	Approximate Quantity fabric supplied (Square yard equivalent)
City of Decatur				
Decatur, Mississippi	7	7	74	8,800
Decatur, Mississippi	9	9	74	9,000
Town of Ruleville				
Ruleville, Mississippi	7	7	74	16,055
Ruleville, Mississippi	9	9	74	7,171
Ruleville, Mississippi	12	12	74	18,274
City of Rexburg				
Rexburg, Idaho	7	7	90	17,438
Rexburg, Idaho	9	9	90	15,279
Rexburg, Idaho	12	12	90	17,438
Total supplied for surfacing streets				195,861
Airport Runways				
War Department				
Ft. McClellan, Anniston, Ala.	9	9	74	20,600
Navy Department				
Anacostia, D. C.	12	12	90	39,908
City of Pocatello				
Pocatello, Idaho	9	9	74	74,547
Total supplied for surfacing airport runways				135,055
Grand total				330,916

Map 5.

Location of Projects in which Cotton and Cotton Products are being tried for Roads, Streets, and Airport Runways.



○ Indicates location of one or more projects.

Ⓡ Cotton supplied for bituminous surfaced highways.

Ⓜ Mats supplied for curing concrete.

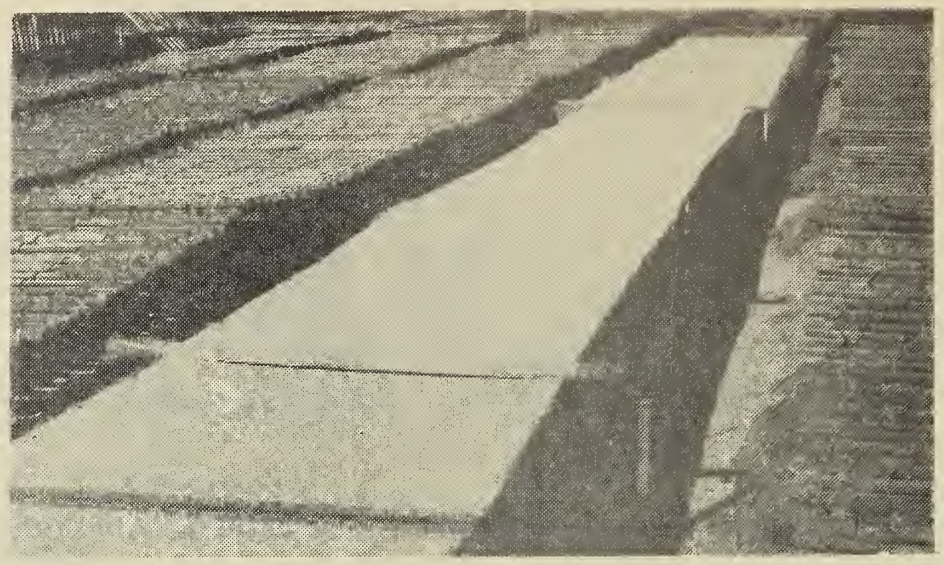
Ⓢ Cotton fabric supplied for street construction.

Ⓐ Cotton fabric supplied for airport runways.

SHADING OR MULCHING TREE SEEDLINGS

In reforestation work, the planting stock is produced by the sowing of seed in nursery seed beds during the Fall or Spring. To insure and hasten germination and to protect seed beds from rains and birds, cotton fabric is applied directly to the seed beds as a mulching material. Following germination, the seedlings are watered, weeded, and in some instances cultivated to bring them to planting size. During critical periods of growth, it is necessary to protect the seedlings against excessive water loss both from the seedling (transpiration) and the soil (evaporation) as well as against high surface soil temperatures. To compare the effectiveness of various materials for these purposes, cotton fabric, laths, and other products are being tried.

Photograph 47



Photograph courtesy of Forest Service, United States Department of Agriculture.

Photograph 47 illustrates the use of open mesh fabric in shading first year white spruce at the Forest Service Hugo Sauer Nursery located near Rhinelander, Wisconsin. A triple layer of fabric was used. The shade so furnished was found entirely satisfactory and reports indicate that the material compares favorably with the slat-wire snow fence commonly used for the purpose. Plans have been prepared for trials to determine whether the half shade stage can be eliminated through the use of cotton fabric. Should the trials prove that stage unnecessary, further substantial savings in labor costs would result.

Photograph 48

Photograph courtesy of Department of Forest Relations, Tennessee Valley Authority.

View of fabric in place and being unrolled on seed beds (photograph 48), Wire pins are used to fasten fabric to the bed. Overhead irrigation system keeps beds constantly moist until germination. When about 60 percent of the seed has germinated, the fabric is rereeled and stored for future use.

Photograph 49

Photograph courtesy of North Carolina Department of Conservation and Development.

Photograph 49 shows cotton fabric being used to catch seed underneath air drying racks. These racks are constructed for opening pine cones in the sun. The pine cones are piled in the rack, as may be seen in several of the racks shown above. As the seed are discharged, they fall through openings in the racks into the cotton fabric which is attached to the racks. In the photograph above, the sag in the cloth on the front center rack shows where the seed collect. After being used, the fabric is removed and stored for the following season.

Methods of Applying Fabric:

a.) Mulch.

The seedbed is prepared in the usual manner and the fabric is laid immediately following seeding operations. For ease of application it is suggested that the fabric be unrolled from a reel. The fabric should be weighted down or held in place by wire staples or stakes. Many of the cooperating agencies are using "L" shaped staples made from No. 12 telephone wire.

After the fabric is applied, the beds should be kept moist throughout the germination period. In most instances, overhead irrigation systems have been used to supplement natural rainfall.

The fabric is removed when germination is well under way. One cooperating agency recommends removal of fabric when 60 percent of the seed has germinated. The fabric should be rereeled and stored for future use.

(b.) Shade.

In photograph 47, above, is illustrated one method of using cotton fabric as a shade for tree seedlings. In this case, a triple layer of cotton fabric was applied. Other agencies, however, have used single layers of cotton fabric with excellent results. The cotton is placed over a snow fence and held in place by sticking a few of the lath through slits cut in the fabric.

It is reported that the use of cotton fabric may possibly obviate the necessity of the half shade stage. This would, of course, bring about substantial savings in labor costs.

Benefit from use of Fabric:

Reports received from cooperating agencies relative to the use of cotton fabric as a mulching material have indicated many benefits which include the following:

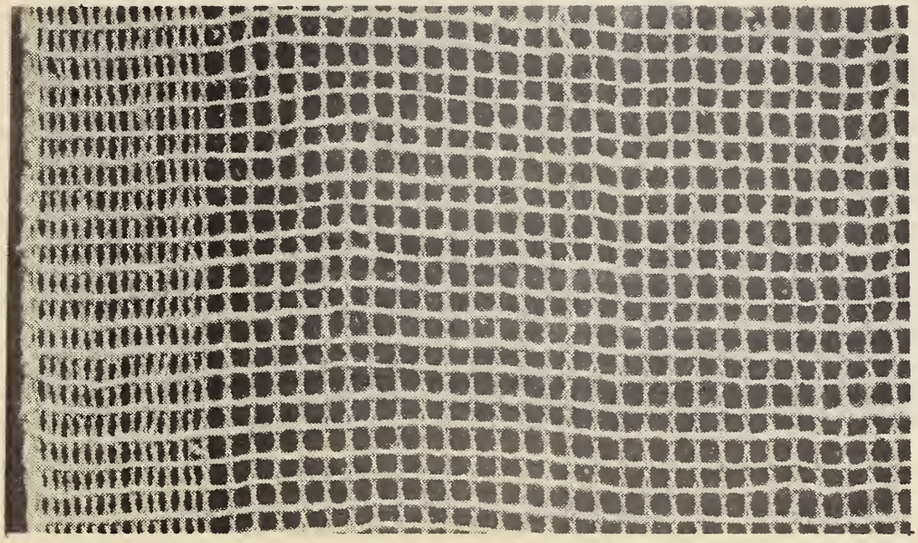
1. Conserves moisture.
2. Increases germination
3. Speeds germination.
4. Uniform germination throughout seedbed
5. Fewer weeds
6. Protects seed from wind, rain, or birds
7. Speeds operations
8. Provides low cost protection
9. Less expensive than straw
10. Cost of application and removal small

Types of Fabric Supplied:

Four types of fabric have been supplied to cooperating agencies for use as a shading or mulching material for tree seedlings.

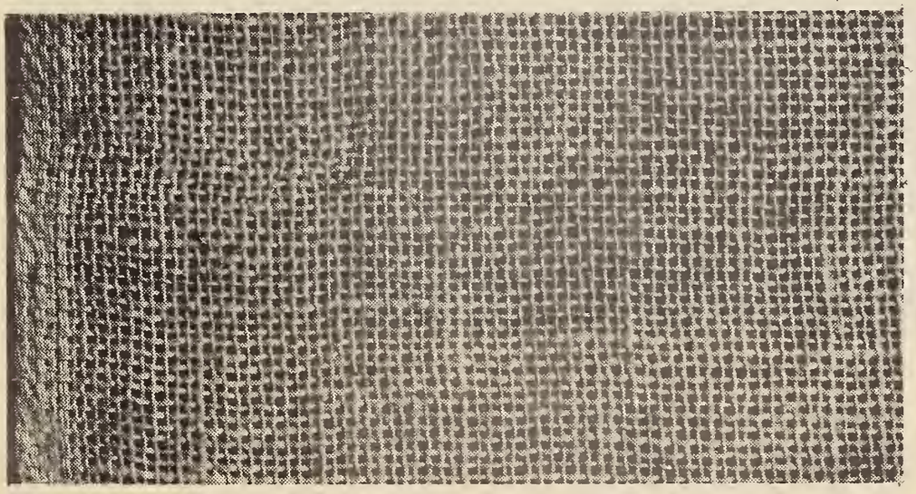
Following are photographs and minimum specifications for each of these fabrics:

Photograph 50



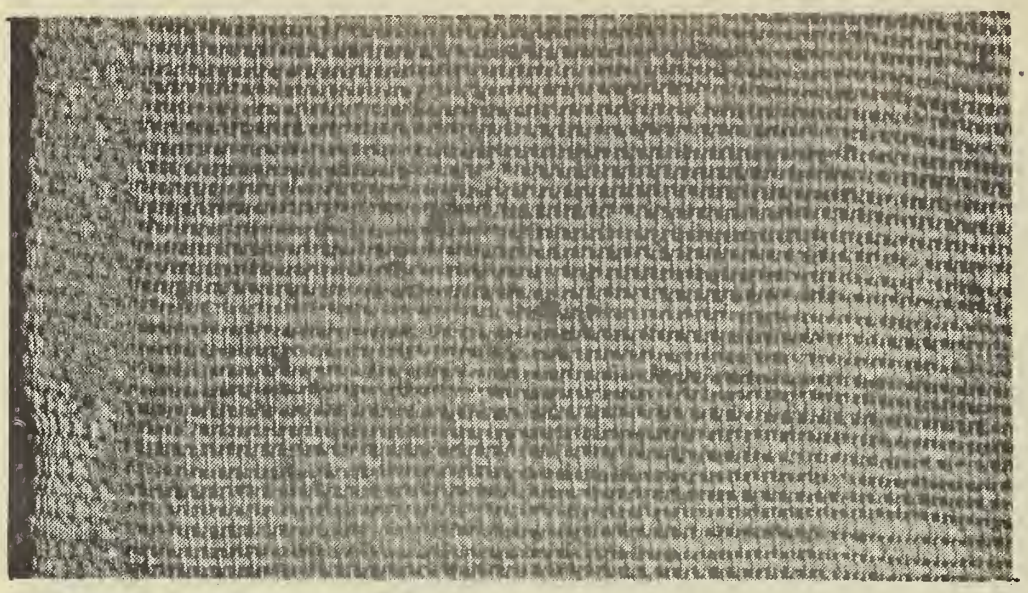
Photograph by Marketing Section, United States Department of Agriculture. 16 x 8 fabric, actual scale (photograph 50).

Photograph 51



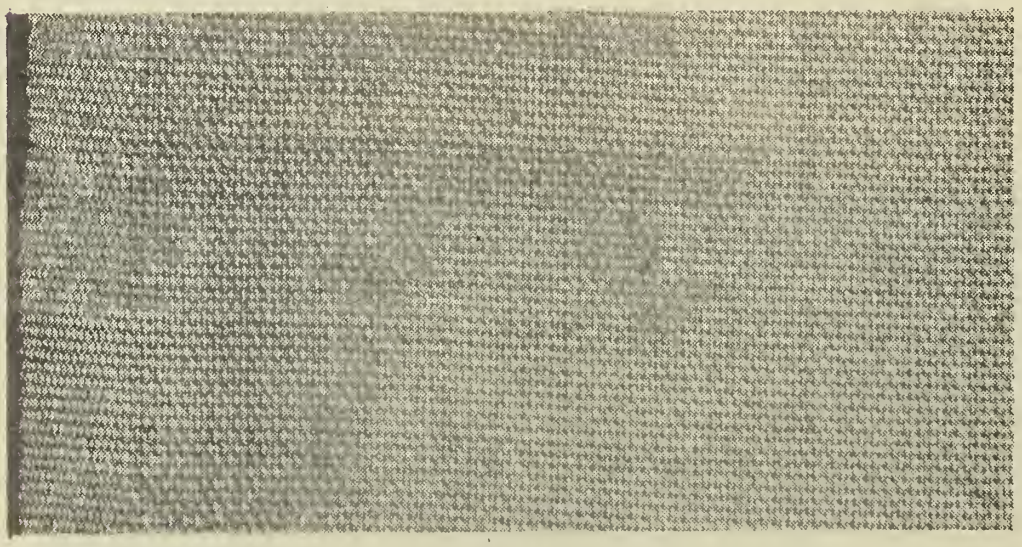
Photograph by Marketing Section, United States Department of Agriculture. 18 x 18 fabric, actual scale (photograph 51).

Photograph 52



Photograph by Marketing Section, United States Department of Agriculture. 30 x 12 fabric, actual scale (photograph 52).

Photograph 53



Photograph by Marketing Section, United States Department of Agriculture, 40 X 20 fabric, actual scale (photograph 53).

The 17($4\frac{1}{4}$x4) X 5 fabric which is also being tried for shading tree seedlings is shown in photograph 36.

Specifications of Fabric						
	16 x 8	17 x 5	18 x 18	18 x 18	30 x 12	40 x 20
Yarn:						
Warp	7½ single	Single	Single	Single	Two-ply	Two-ply
Filling	3-3/4 "	Four-ply	"	"	Single	Single
Weave	Leno	Leno 1/	Plain	Plain	Plain	Plain
Width (inches)	40 and 48	40	48	56	54 and 56	40 and 54
Thread count:						
Warp	16 (8 x 2)	17 (4¼ x 4)	18	18	30 2/	40 2/
Filling	8	5	18	18	12	20
Weight per square yard (ounces)	3.12	3.20	5.44	5.46	6.0	6.66
Breaking Strength						
Warp (pounds)	35	35	50	60	45	45
Filling (pounds)	20	20	50	55	45	45
Selvage	each side	each side	each side		each side	each side
Ends	32	34	28		32	32
Width (inch)	1	1	3/4		1/2	1/2
Weave	Leno	Leno	Plain		Plain	Plain

1/ Leno weave with two warp ends working as one.

2/ Warp threads constituting not less than 32 percent nor more than 40 percent, by weight, of the fabric excluding the selvage.

Cooperating Agencies

Name of cooperating agency and where used	Type fabric supplied: Warp	Filling	Width (Inches)	Approximate quantity supplied (square yard equivalent)
United States Forest Service				
Globe, Arizona	16	8	40	1,111
Tucson, Arizona	16	8	40	2,222
Russelville, Arkansas	30	12	54	7,430
Glendora, California	16	8	40	556
Fort Collins, Colorado	16	8	40	222
Monument, Colorado	30	12	54	37,500
Idaho City, Idaho	16	8	40	556
Manhattan, Kansas	30	12	54	3,000
Pollock, Louisiana	30	12	54	23,704
Brooklyn, Mississippi	30	12	54	24,488
Freemont, Nebraska	30	12	54	3,000
Halsey, Nebraska	30	12	54	15,000
Cloudcroft, New Mexico	16	8	40	111
Las Cruces, New Mexico	16	8	40	333
Norwich, New York	16	8	40	778

Cooperating Agencies, continued.

Name of cooperating agency and where used	Type fabric supplied: Warp	Filling	Width (Inches)	Approximate quantity supplied (square yard equivalent)
Jamestown, North Dakota	30	12	54	3,000
Columbus, Ohio	16	8	40	111
Oklahoma City, Oklahoma	30	12	54	3,000
Portland, Oregon	16	8	40	111
Brookings, South Carolina	30	12	54	3,000
Newberry, South Carolina	30	12	54	1,542
Wichita Falls, Texas	30	12	54	3,000
Laramie, Wyoming	30	12	54	300
United States Soil Conservation Service				
Washington, Indiana	40	20	54	15,000
Paducah, Kentucky	40	20	54	15,000
Faribault, Minnesota	17	5	40	1,667
Dayton, Ohio	16	8	40	2,769
Zanesville, Ohio	40	20	54	15,000
Spartanburg, South Carolina	16	8	40	1,411
Bureau of Reclamation				
Mitchell, Nebraska	16	8	40	2,100
Tennessee Valley Authority				
Sheffield, Alabama	30	12	54	40,881
Clinton, Tennessee	30	12	54	37,726
Navy Department				
Charleston, South Carolina	16	8	48	980
United States Bureau of Plant Industry				
Yuma, Arizona	30	12	54	150
Arkansas Forestry Commission				
Little Rock, Arkansas	40	20	54	3,100
California Department of Natural Resources				
Davis, California	40	20	54	680
Connecticut Park and Forest Commission				
Torrington, Connecticut	30	12	54	300
Florida Forest and Park Service				
Olustee, Florida	30	12	54	15,750
Georgia Division of Forestry				
Albany, Georgia	30	12	54	8,556
Georgia School of Forestry				
Athens, Georgia	18	18	56	9,610
Indiana Conservation Department				
Bluffton, Indiana	40	20	54	1,700
Brownstown, Indiana	40	20	54	3,207
Henryville, Indiana	40	20	54	3,134

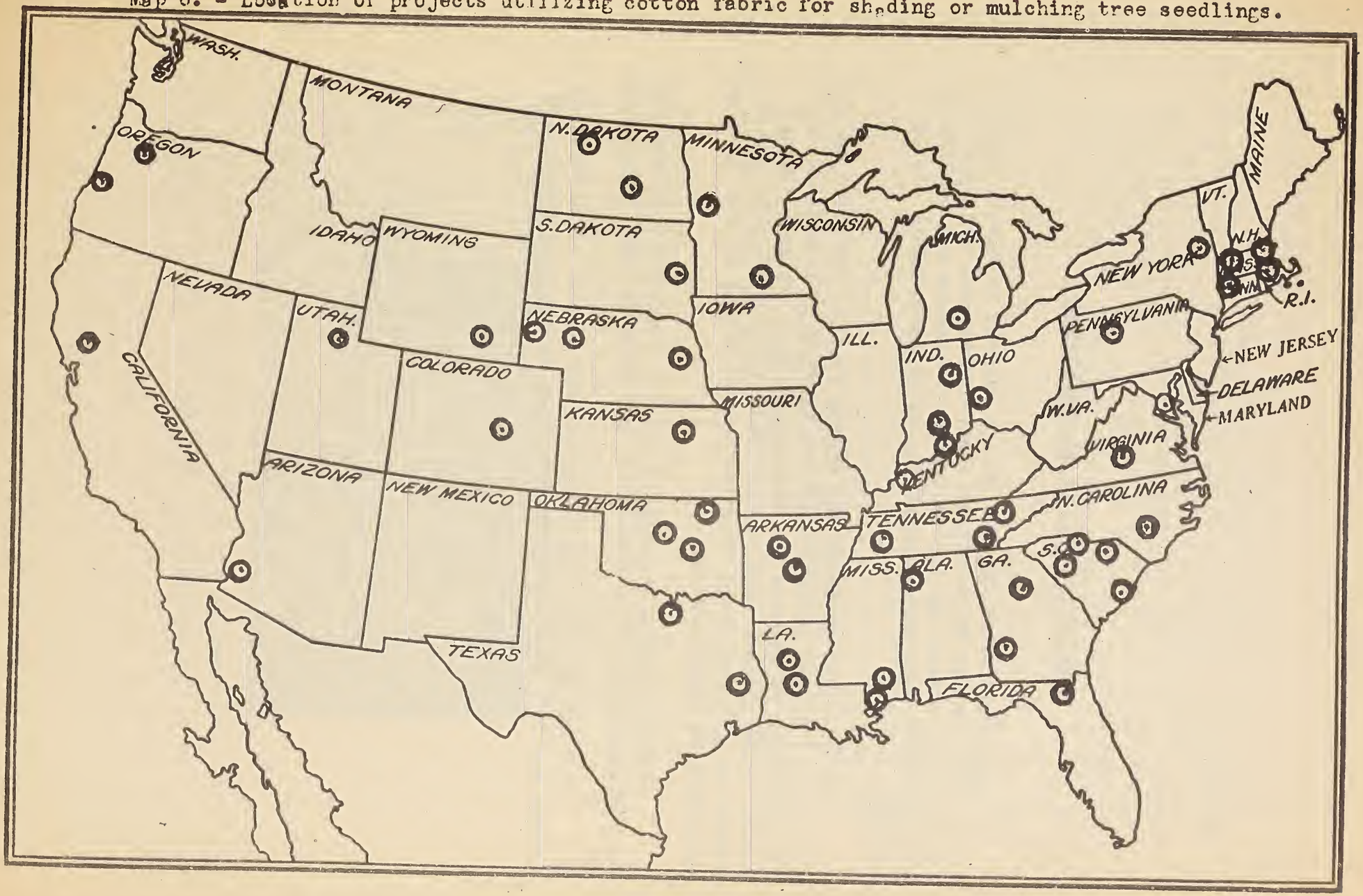
Cooperating Agencies, continued.

Name of cooperating agency and where used	Type fabric supplied: Warp	Filling	Width (Inches)	Approximate quantity supplied (square yard equivalent)
Louisiana Department of Conservation				
Woodworth, Louisiana	40	20	54	2,318
Maryland Department of Conservation				
College Park, Maryland	40	20	54	752
Massachusetts Department of Conservation				
Amherst, Massachusetts	40	20	54	4,586
Bridgewater, Massachusetts	40	20	54	4,616
Clinton, Massachusetts	40	20	54	4,656
Michigan State College, Forestry Department				
East Lansing, Michigan	18	18	48	5,756
Minnesota Department of Conservation				
Akeley, Minnesota	40	20	54	74,955
Mississippi Forest and Park Service				
Perkinston, Mississippi	40	20	54	18,780
New York Conservation Department				
Saratoga Springs, N. Y.	40	20	54	39,792
North Carolina Department of Conservation and Development				
Clayton, North Carolina	40	20	54	15,538
North Dakota School of Forestry				
Bottineau, North Dakota	40	20	54	7,803
Oklahoma Forest Service				
Noble, Oklahoma	30	12	54	3,118
Oklahoma Planning and Resources Board				
Stillwater, Oklahoma	40	20	54	3,124
Oregon State Board of Forestry				
Corvallis, Oregon	40	20	40	1,428
Pennsylvania Department of Forests and Waters				
Clearfield, Pennsylvania	16	8	40	11,094
Franklin, Pennsylvania	16	8	40	11,531
South Carolina Commission of Forestry				
Camden, South Carolina	30	12	56	84,980
Tennessee Division of Forestry				
Jackson, Tennessee	30	12	54	4,935
Pikeville, Tennessee	30	12	54	4,684

Cooperating Agencies, continued.

Name of cooperating agency and where used	Type fabric supplied: Warp	Filling	Width (Inches)	Approximate quantity supplied (square yard equivalent)
Texas Forest Service				
Lufkin, Texas	40	20	54	3,105
Virginia Forest Service				
Charlottesville, Virginia	30	12	54	15,153
Total quantity fabric supplied:				635,511

Map 6. - Location of projects utilizing cotton fabric for shading or mulching tree seedlings.



⊙ Indicates location of one or more projects.

PROTECTING FRUITS AND VEGETABLES

Many fruits and vegetables are subject to insect infestations and diseases which affect their development and impair their market value. By the exclusion of insects and control of disease, the value and palatability of these products are increased.

In the case of dried and drying fruits, the problems occasioned by insect infestations are especially troublesome and the exclusion of insects has been given much thought. Experimental trial use and more recent field tests utilizing cotton fabric to prevent insect infestations of drying fruits have been successfully demonstrated.

Another highly successful use for cotton fabric has been in connection with the control of curly-top disease on tomatoes.

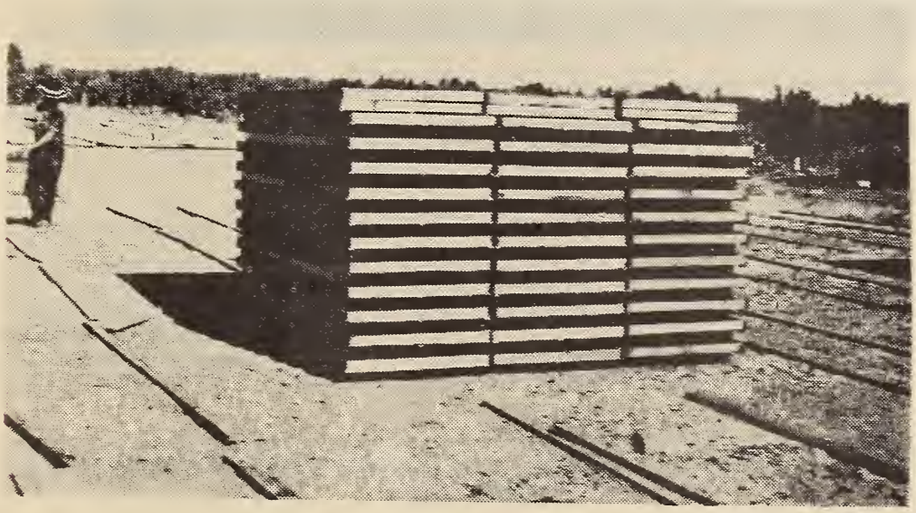
Cotton has also been supplied for use in the harvesting of prunes and for other purposes specified below.

Protecting drying fruits:

Laboratory experiments over a period of several years made by the Fresno, California Field Station of the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, indicate that cotton fabric is a very effective material for the purpose of excluding insects. To test the usefulness of cotton fabric under field conditions, the Agricultural Adjustment Administration supplied cotton fabric to the Extension Service of the University of California for trial use as a protection against insects in the curing of peaches. In these tests, the University of California had the cooperation of the Dried Fruit Association of California and the technical assistance of representatives of the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture. These field tests proved as successful as the laboratory test conducted earlier. The average Raisin Moth infestation for exposed lots of peaches throughout the peach growing area of California was 45.2 percent, while the average infestation for protected lots was 8.7 percent. In some instances there was 100 percent infestation in exposed lots and no infestation in protected lots.

Photographs 54 to 58 illustrate the use of cotton fabric in the protecting of drying fruits.

Photograph 54

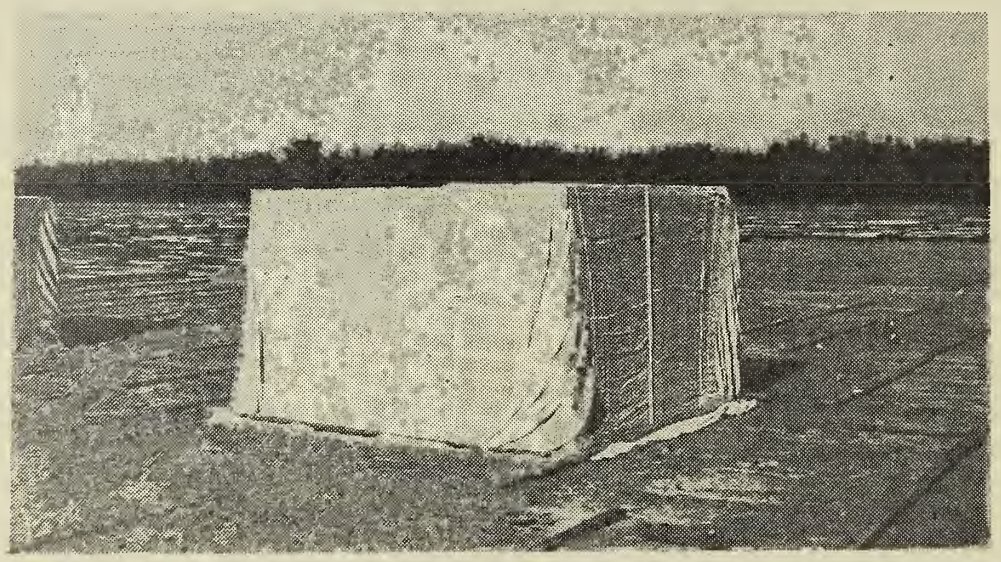


Photograph courtesy of Dried Fruit Association of California.

Drying peaches. A stack of three piles of 3 x 8 trays stacked in the "stagger" fashion, (photograph 54). The "stagger" method is used in many dry yards to permit a better circulation of air.

Trays of peaches are stacked when the fruit is about two-thirds dry. The trays are stacked during the hot part of the day, never in the early morning, late afternoon, or evening when moths may be settling on the fruit. Except where the "stagger" method, shown in photograph 54 is used, empty trays are placed on the top of each pile so that they overhang about 12 inches in order that the protective cotton cloth may not touch the piles at the sides. Where the trays are "staggered" it is not necessary to have an overhang.

Photograph 55



Photograph courtesy of Dried Fruit Association of California.

Drying peaches. View of same stack shown in photograph 54 after it was covered with shade cloth. It took two men about five minutes to fold and apply the shade cloth to this stack, (photograph 55).

In applying the fabric, which was sewed into sheets 27 feet by 28 feet in size, the sheet is folded ends to middle until it forms a narrow folded strip about two feet wide, or less, and as long as the sheet itself. The folded strip is then thrown over the pile in such a way each end will touch the ground in the same manner on the opposite sides of the pile. The sheet should then be unfolded toward each end until it touches the ground.

The sides and ends of the shade cloth is then made fast to the ground so that there is no possibility of any insect entering the pile. This is done with weights consisting of tree props, old lumber, or other material.

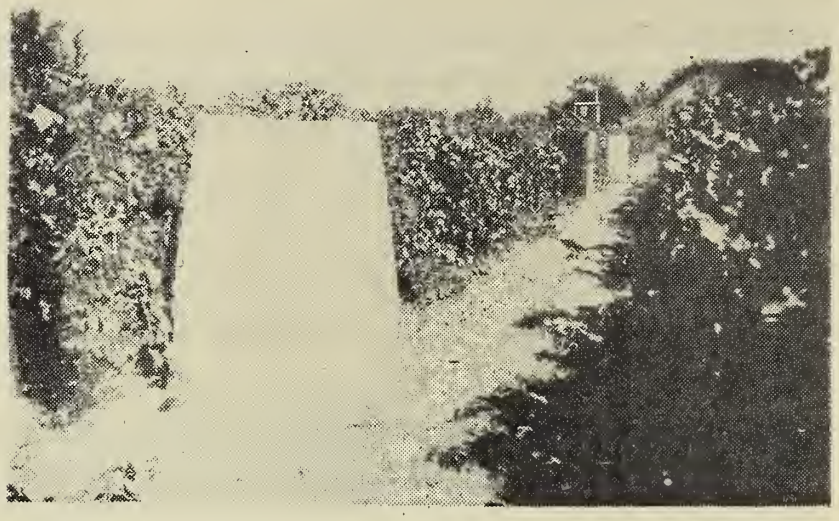
The shade cloth is removed after the peaches are sufficiently dry, and the peaches are boxed immediately. In this test, the number of days of stack drying varied from 2 to 19 days. The fabric is removed only when the sun is shining.

Photograph 56

Photograph courtesy of Fresno, California Field Station, Bureau of Entomology and Plant Quarantine of United States Department of Agriculture.

Drying figs. Illustration of cotton fabric being used as a protection against insect infestation in the commercial drying of figs, (photograph 56).

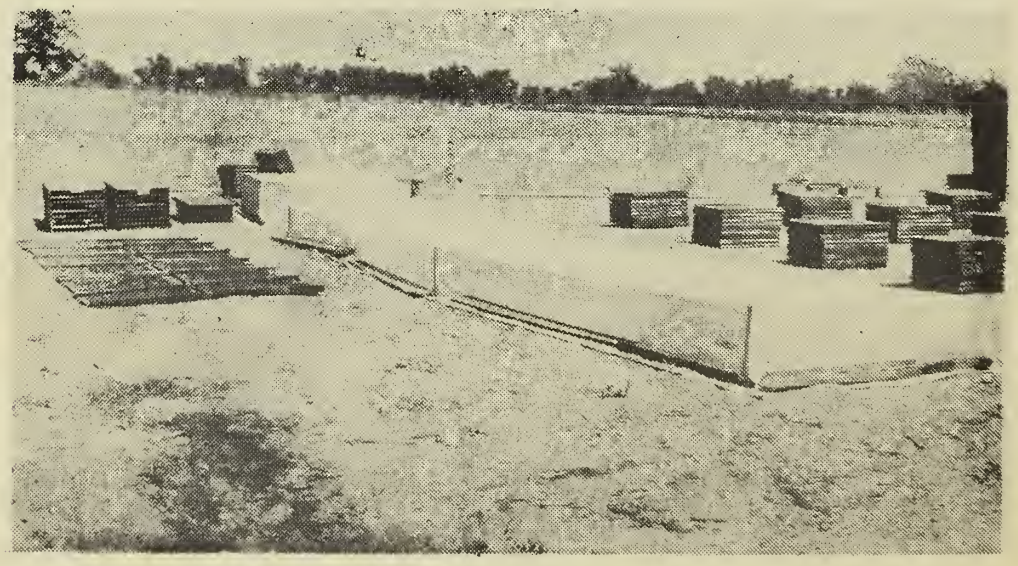
Photograph 57



Photograph courtesy of Fresno, California Field Station, Bureau of Entomology and Plant Quarantine of United States Department of Agriculture.

Drying raisins. Shade cloth over stacked trays of raisins, (photograph 57).

Photograph 58



Photograph courtesy of Fresno, California Field Station, Bureau of Entolomology and Plant Quarantine of United States Department of Agriculture.

Experimental drying of fruits. View of cotton fabric being used in the drying of apricots, nectarines, and peaches, (photograph 58)

Type of fabric supplied:

The construction of cotton fabric supplied for use in the drying of fruits is as follows:

Yarn: Single.

Weave: Plain.

Weight: About 2 ounces per square yard.

Construction:

a. Warp: Ground construction 16 threads per inch. At regular intervals and at not more than 24 inches a reinforcing strip 1/2 inch wide consisting of 38 warp threads, weaving 2 threads as one. Selvage 7/8 inch wide consisting of 48 warp threads per inch on each side.

b. Filling: Ground construction 14 threads per inch. At intervals of 16 inches the number of filling threads double for a distance of 3/8 of an inch.

Breaking strength (grab method):

a. Body of fabric between reinforcements:
   1. Warp: 20 pounds.
   2. Filling: 10 pounds.

b. Warp reinforcing strip consist of 38 warp threads weaving 2 ends as one, 45 pounds.

c. Filling reinforcing strips made by doubling the number of filling threads per inch for a distance of 3/8 inch, 30 pounds.

Protecting tomato plants:

In some areas, about 75 percent of the yearly damage to tomatoes by curly-top disease is caused by the transmission of the blight by beet leafhoppers during the period of their migration, which lasts about a month. The placing of covers over the young tomato plants during the period of movement of the beet leafhoppers affords a high degree of protection against the curly-top disease transmitted by these pests, and also protects the plants from injury by late frost

Photographs 59, 60 and 61 indicate how covers were placed over tomato plants at the Hooper, Utah Experimental Field of the Bureau of Entomology and Plant Quarantine.

Photograph 59

Photograph courtesy of Division of Truck Crop and Garden Insect Investigation, Bureau of Entomology and Plant Quarantine of United States Department of Agriculture.

Photograph 59 illustrates the method of using a cotton fabric cover for tomato plant. Part of the cover turned back to show a tomato plant, approximately 6 inches high, which had been protected successfully from frost. The primary use of the fabric, however, was to protect the tomato plant against curly-top disease.

The cotton fabric is cut into 36-inch squares and held in place over the tomato plants by two wire supports, the edges of the fabric being covered by soil. Plants were set in the field approximately 15 days in advance of the normal planting date. It was found that the protected plants did not suffer noticeable injury while many unprotected plants, in an adjacent field, were killed or injured severely.

Photograph 60

Photograph courtesy of Division of Truck Crop and Garden Insect Investigation, Bureau of Entomology and Plant Quarantine of United States Department of Agriculture.

General view of 2-acre field of tomato plants protected by covers, (photograph 60). The covers remained over the plants from May 1, to June 18, 1938.

Photograph 61

Photograph courtesy of Division of Truck Crop and Garden Insect Investigation, Bureau of Entomology and Plant Quarantine of United States Department of Agriculture.

Removing covers from tomato plants. One man pulls off the cotton fabric, another follows along and picks up the wire supports, (photograph 61).

It was found that there were approximately 50 percent less of the plants infected by the curly-top disease in the protected field than in the unprotected field. The effectiveness of the covers as a protective agency was reduced during 1938 by the movement of leafhoppers from weeds in the field to the tomato plants after the covers were removed.

Type of fabric supplied:

Following are minimum specifications of fabric supplied for protecting tomato plants against curly-top disease:

Minimum specifications:

Yarn: Single.

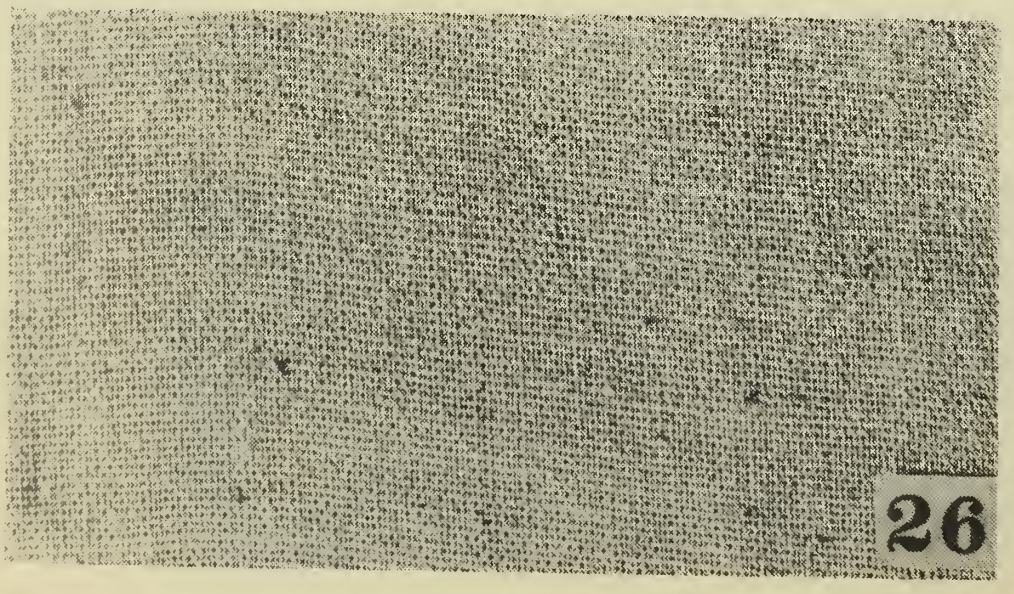
Weave: Plain.

Width: 36 inches.

Weight: 1.7 ounces per square yard.

Thread count:
Warp: 44
Filling: 36

Photograph 62



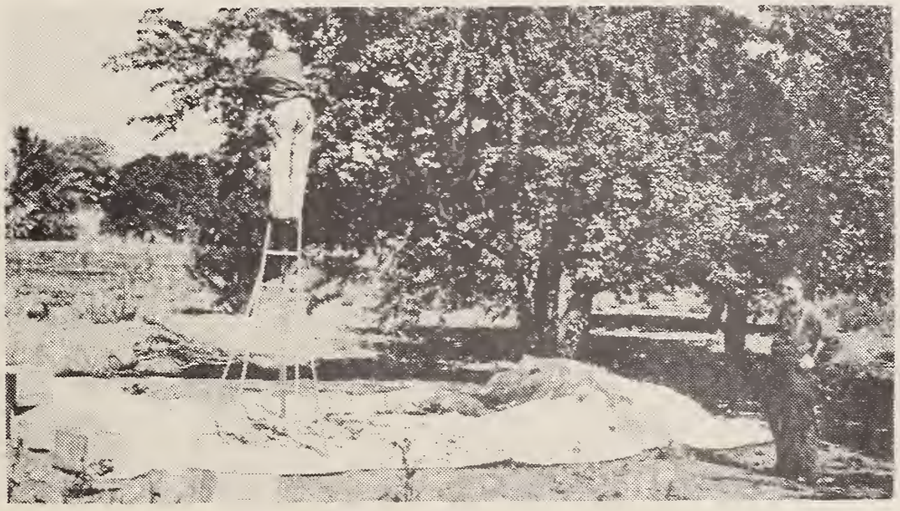
Photograph by Marketing Section, United States Department of Agriculture.

Actual scale photograph of 44 x 36 fabric, (photograph 62).

Cotton for prune harvesting:

The use of cotton in connection with the harvesting of prunes is pictured in photograph 63.

Photograph 63



Photograph courtesy of Oregon State Agricultural College, Corvallis, Oregon.

Prune harvesting. Fabric is spread on ground and limbs of tree shaken, permitting fruit to drop on fabric, (photograph 63).

Other types of fabric supplied:

Various types of fabric were supplied to cooperating agencies for use in the protection of fruits and vegetables and related purposes in addition to the fabrics described above. All these fabrics are of plain weave and single yarns. Following is a list showing thread count, width, and minimum weight of each fabric:

Cooperating Agencies

Name of cooperating agency, where used, and purpose for which used.	Type of fabric: Thread count: Warp	Filling	Width (inches)	Approximate quantity supplied (Square yard equivalent)
Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, Truck and Garden Insect Investigations:				
Logan, Utah				
Protective covering for tomato plants	44	36	36	7,500
School of Agriculture, University of California, Fresno,				
Protective covering during curing of peaches	16	14	36	23,100
Protective covering for raisins during sweating processes	16	14	36	1,800
Bureau of Plant Industry, United States Department of Agriculture:				
United States Field Station, Yuma, Arizona,				
Covering for date bunches	30	12	54	150
Oregon State Agricultural College, Corvallis, Oregon, Food Products Laboratory				
Use in prune harvesting operations	40	28	40	7,238
Department of Farm Crops				
Lath-house and cold frame covering	48	48	36	223
Bags for handling seeds	40	28	40	2,222
Catching shattered grass seed in field	40	28	40	278
Hay caps	40	28	40	222
Support and shade for sweet pea crops	28	24	36	840
Department of Horticulture				
Shading bramble fruit to prevent sunburn	32	28	40	111
Shading bramble fruit to prevent sunburn	9	9	74	206

Cooperating Agencies, continued

Name of cooperating agency, where used, and purpose for which used.	Type of fabric: Thread count: Warp	Filling	Width (inches)	Approximate quantity supplied (Square yard equivalent)
Department of Botany				
Experiments in threshing beans	40	28	40	33
Control of curly-top disease	22	18	36	1,680
Control of curly-top disease	28	24	36	240
Control of curly-top disease	36	32	36	360
Control of curly-top disease	44	36	36	240
Control of curly-top disease	9	9	74	616
Insect cages used in control of curly-top disease	64	60	38.5	214
Cloth for onion drying	44	36	36	250
Control of obscure Northwest aster diseases	40	36	36	200
Total quantity of fabric supplied				47,723

COTTON FABRIC FOR FUMIGATING TOBACCO SEED BEDS

Tobacco Downy Mildew or the Blue Mold disease of tobacco has become within recent years of great economic importance in nearly all of the tobacco growing states of the United States and Canada. It is also of primary importance in Australia. A close mesh cotton fabric is being tried in connection with blue mold control.

Tobacco blue mold is caused by the fungus Peronospora tabacina. It destroys the leaf tissue and if the bud is infected the plant dies. If the bud is not infected the seedling recovers within about two weeks and may be transplanted to the field. Because of the great hazards involved where blue mold is likely to attack, tobacco growers in the past few years have adopted a policy of sowing areas of seed beds equal to 3 to 4 times what they normally require.

Pathologists now recommend two methods for control of blue mold in tobacco seed beds. One is to spray the seedlings with copper oxide, to prevent or reduce the disease; the other method is by fumigation. Benzol and related compounds as monochlorobenzene and paradichlorbenzene have been used successfully as a fumigant.

To hold the fumes within the bed a closely woven cotton fabric is spread over the seed beds at night in addition to the regular "tobacco canvas" cover used to prevent damage by frost. This closely woven cotton fabric is removed from the beds in the morning so normal plant growth will not be affected.

Size of seed beds:

Properly used fumigation methods suggest seed beds about six feet wide and not over 100 yards long. Beds should be enclosed with boards, about one inch by 12 inches, set two to four inches in the ground.

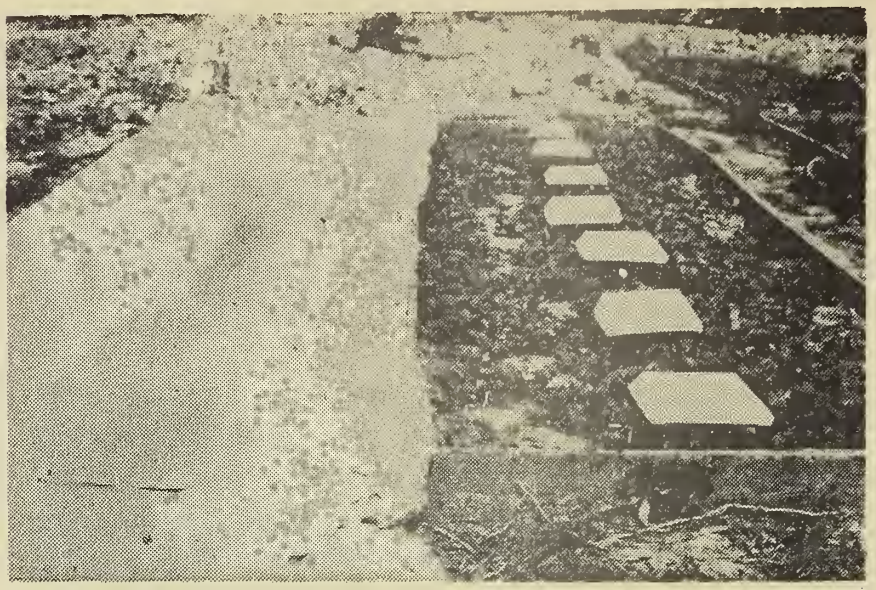
Method of applying fumigant:

Either of two methods may be used to apply the fumigant, commonly called "benzol".

1. In open pans set at proper intervals in the seed bed. These may be ordinary bread pans set under wooden or metal canopies which are used to prevent rain falling into the pans and scattering the benzol liquid upon the adjacent plants. One pan 4 inches by 8 inches is usually used for 36 square feet of bed area. Each pan is filled separately.

2. By an evaporator employing a cotton wick 15 inches wide by 8 inches long which has been designed by E. G. Beinhart of the Marketing Section, Agricultural Adjustment Administration.

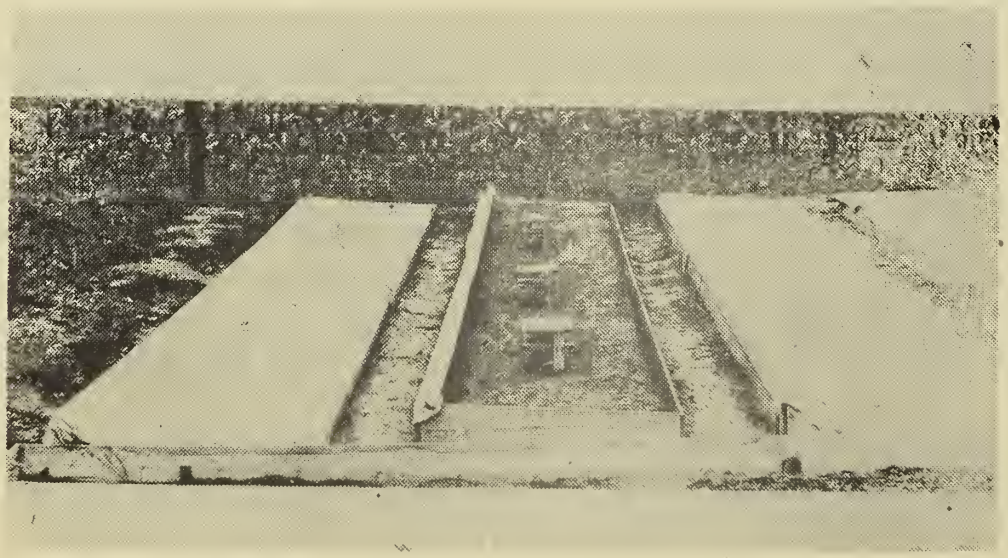
Photograph 64



Photograph by Marketing Section, Agricultural Adjustment Administration, United States Department of Agriculture.

Photograph 64 shows a tobacco seed bed with right side of the bed uncovered to indicate placement of evaporating pans for benzol (method 1). These pans are equipped with hoods to prevent rain water splashing the liquid benzol on the plants. The cotton fabric is shown in place on the left side of the seed bed. It is tightly secured to the border board by straps or nail clips.

Photograph 65



Photograph courtesy of North Florida Experiment Station, Quincy, Florida.

Photograph 65 shows seed beds with fabric in place and also one bed uncovered (method 1). The beds shown in the photograph are 4 feet wide. A wider seed bed is customarily used, a width of 6 feet being recommended.

Photograph 66

Photograph courtesy of Tobacco Experiment Station, Oxford, North Carolina.

View (photograph 66) of six beds showing effects of various treatments on the tobacco plants (method 1).

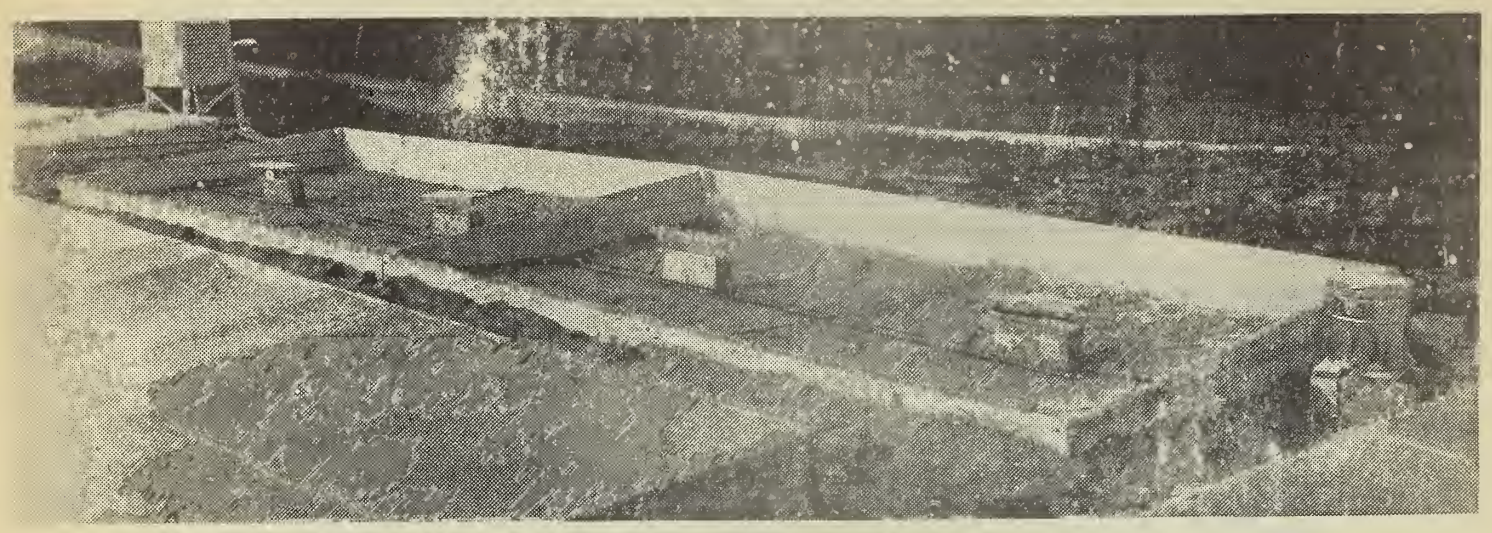
Bed in right foreground protected against downy mildew by treating with benzol vapors each night. Complete control secured.

Bed in left foreground, two days application then two days no application. Duplicated in bed just beyond one in right foreground. Control not satisfactory.

Two end beds, four days treatment, four days no treatment. Little if any value from treatment.

Left center compartment, is an untreated check in which all plants are severely affected.

Photograph 67



Photograph courtesy Dr. J. A. Pinckard, Virginia Experiment Station, Chatham, Virginia.

Photograph 67 shows battery of four wick fumigators in, and supply reservoir on outside of and at right end of, seed bed with connecting pipes. This apparatus is set up while plants are still small to expedite installation and prevent damaging large seedlings when fumigation is necessary. One fumigator is sufficient for 130 square feet of bed. Note in left foreground the standard seed bed cloth in position. When benzol is to be applied this cloth is covered at night with sheeting tightly drawn to retain the fumes. It has been found that the retention of fumes is increased when the sheeting cover has been wet by rain, dews or by sprinkling.

The evaporator is automatic in operation. This system should be set so the supply reservoir is at the highest part of the seed bed and the last fumigator in the series at the lowest end so the benzol may be supplied to each fumigator by gravity. Fumigatio n is begun when blue mold is believed to be present in the seed bed or is reported in the neighborhood. In clear weather benzol is applied only at night whereas in rainy weather fumigation is continuous throughout the day. The benzol liquid sufficient for all the fumigators in the series is supplied to the reservoir. The amount of exposure of the wick surface is adjustable, 1 inch exposure usually being sufficient. An extra cotton sheet is spread over the canvas cover of the seed bed or in northern areas over the glass sash of the cold frames. The extra cover is spread at sundown and it is left on the bed until just before sunrise, when it is removed and rolled back for use again in the evening. After the cover has been spread and secured firmly the benzol liquid is released from the supply reservoir through the valve at its base.

The liquid enters the first fumigator, and passes through the outflow pipe (which is set up 1 inch from the bottom of the tank) into the second fumigator, and so on until the entire series is supplied.

The benzol evaporates from the wicks throughout the night and maintains a sufficient amount of the gas to inhibit sporulation.

Standard practice with tobacco beds in the southern areas usually requires an open mesh cloth of about 16 x 16 mesh to protect the bed from winds, insects and to give a blanketing effect. In the northern states a sheeting of 40 x 40 mesh is usually employed or glass covered cold frames are used. In any case an additional cover of 60 x 60 or 64 x 64 mesh sheeting is required to retain the fumes within the bed. Leakage easily occurs in the glass covered and the open mesh cloth covered beds, even where 40 x 40 mesh cloth is used, and the extra fumigating cloth is required.

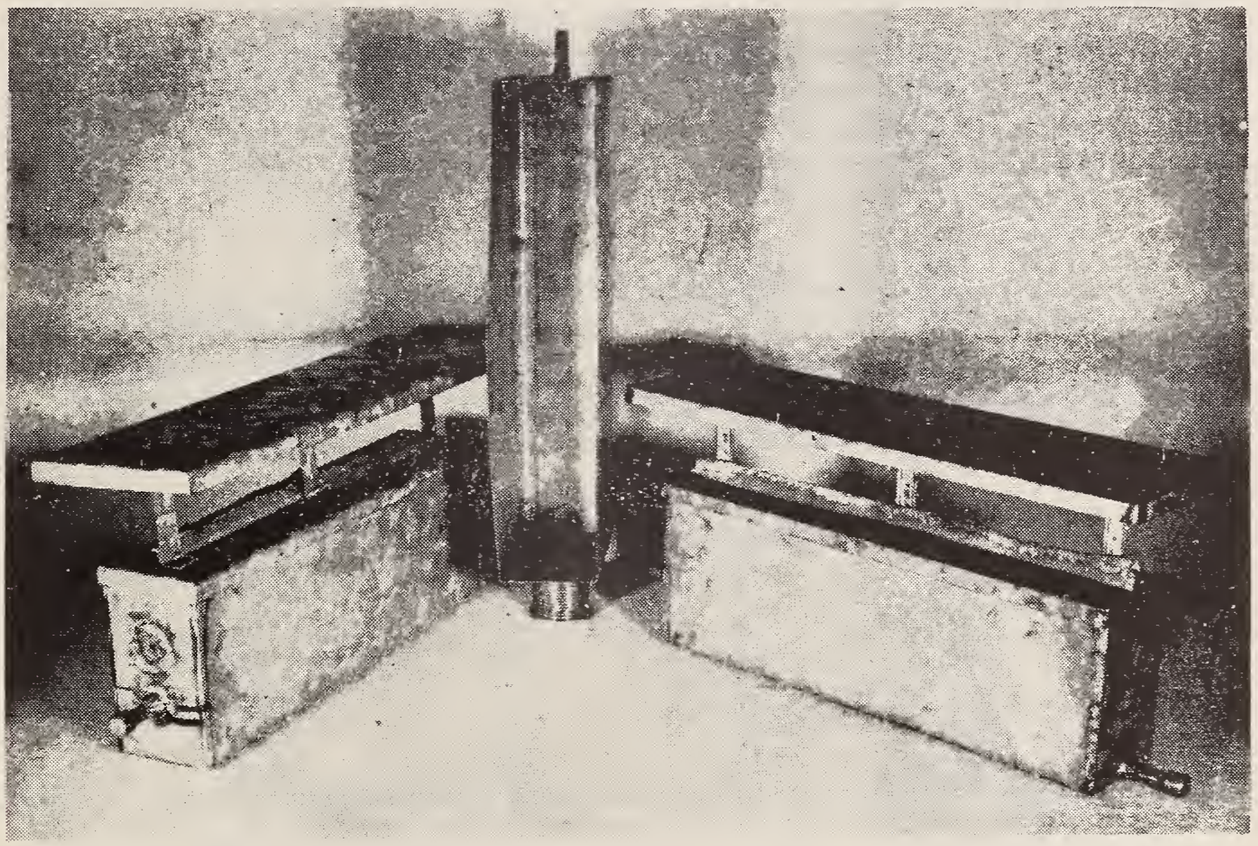
The South Carolina Experiment Station reports having controlled the blue mold by using paradichlorbenzene crystals as the source of fumigating gas. These crystals are spread upon shelves erected in the bed about 8 inches above the ground. The crystals dissipate upon exposure to the air filling the bed area with paradichlorbenzene vapors. The additional cover of sheeting is necessary to be applied at night to retain the fumes.

Photograph 68

Photograph courtesy Dr. F. A. Wolf, Duke University, Durham, North Carolina.

View (photograph 68) of seed bed with open pan evaporator in foreground (method 1) and three wick-fumigators in upper right (method 2). Where the open pans are used liquid benzol is poured into each pan separately. Note the metal canopy over the pan in right foreground. The location of three fumigators are marked by two white stakes placed by the sides of each apparatus. The supply line leading to the first fumigator is seen at the edge of the bed to the right of the first fumigator. The regular seed bed cloth has been removed because of the advanced plant development. The fumigating cloth removed during the day is seen in the upper left corner.

Photograph 69



Photograph courtesy Dr. J. A. Pinckard, Virginia Experiment Station, Chatham, Virginia.

Photograph 69 shows a detailed view of a wick fumigator. This apparatus consists of a bottom reservoir and a slotted lid with canopy. The fumigator reservoir is made of 26 gauge galvanized metal, all laps soldered. It is 15 inches long, 3 inches wide and 6 inches deep. The 1/8 inch galvanized inlet pipe is soldered into the bottom at one end (as shown on right in above figure). The 1/8 inch outlet pipe is set in opposite end one inch above bottom to allow pan to retain sufficient liquid benzol for one night's treatment. The cover is fitted snugly and carries a slot 1/4 inch wide and 14-1/2 inches long through its middle for the cotton wick, which is exposed 1 inch. A canopy is supported 2 inches above the cover, to protect the wick from rain or condensed dew dropping on it from the cover cloths. The three canopy supports are perforated with pin holes to allow supporting pins to hold the wick if high exposures are desired.

Types of fabric supplied:

Various types of cotton sheeting were supplied for use in connection with the fumigation of tobacco seed beds. All these fabrics were of single yarn and plain weave construction. Minimum specifications for thread count, width, and weight follow:

Types of Fabric Supplied

Thread Count		Width (inches)	Weight per square yard equivalent (ounces)
Warp	Filling		
40	40	32	2.70
48	48	31	3.48
56	60	60	3.78
62*	58	36	6.40
64	64	52	4.15
64	64	63	4.11
64	64	81	4.22
68	72	60	5.10

* Portion of fabric supplied inpregnated with developed compound of a pyroxylin type finish.

Agencies Cooperating in the use of Cotton Fabrics for Fumigating Tobacco Seed Beds.

Name of Cooperating Agency and Where Used	Type of Fabric: Thread Count	Type of Fabric: Width (inches)	Quantity Fabric Supplied Sq. Yd. Equiv.
Bureau of Plant Industry			
Oxford, North Carolina **	62 x 58	36	1,000
Henderson, North Carolina	62 x 58*	36	300
Chatham, Virginia	62 x 58*	36	250
Washington, D. C.	62 x 58*	36	450
Arlington, Virginia	64 x 64	63	1,750
North Florida Experiment Station			
Quincy, Florida	56 x 64	60	340
Quincy, Florida	68 x 72	60	167
North Carolina Department of Agriculture			
Oxford, North Carolina	64 x 64	63	438
North Carolina Cooperation Extension Work			
Raleigh, North Carolina	64 x 64	81	1,958
Virginia Agricultural Experiment Station			
Chatham, Virginia	64 x 64	81	1,958
Chatham, Virginia	40 x 40	32	138
Chatham, Virginia	48 x 48	31	131
Total Fabric Supplied	xxx	xx	9,071

* Treated fabric.
** Includes 500 yards for Duke University.

OTHER NEW USES FOR COTTON

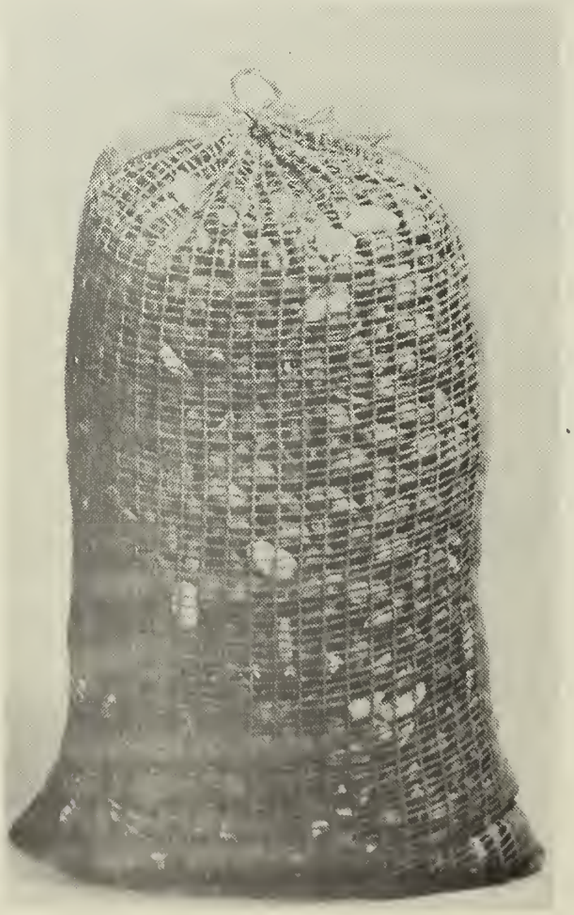
Bags for packaging peanuts

The use of consumer-size packages for agricultural products is rapidly increasing in importance and provides an excellent potential field of new use for cotton. Claims made for cotton consumer-size bags are that they make attractive packages; they supply a suitable surface for brand names and make possible effective advertising; they are durable and little affected by moisture; they represent minimum tare weight, and they have a high salvage value.

To test the merits of this type package under standard conditions of handling and on a commercial scale, open-mesh cotton bags were supplied to cooperating agencies for use in packaging peanuts. The bags were of two sizes, one to hold 2 pounds of unshelled roasted peanuts, and the other to hold 5 pounds of shelled raw peanuts. These sizes also represented a new departure in marketing peanuts.

Reports received to date indicate considerable interest in consumer-size cotton bags.

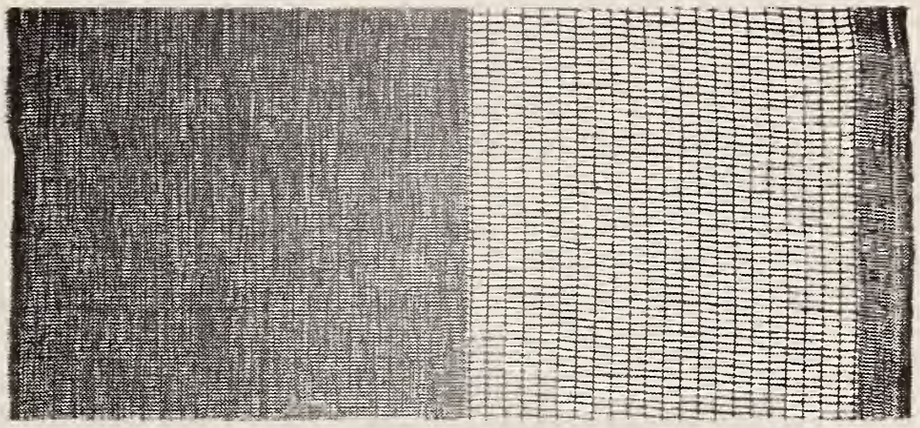
Photograph 70.



Photograph by Marketing Section
Agricultural Adjustment Administration,
United States Department of Agriculture

Duplex cotton bag used for packaging five pounds shelled raw peanuts, (photograph 70) about three sevenths actual size. Bag made from type of fabric pictured in photograph 71.

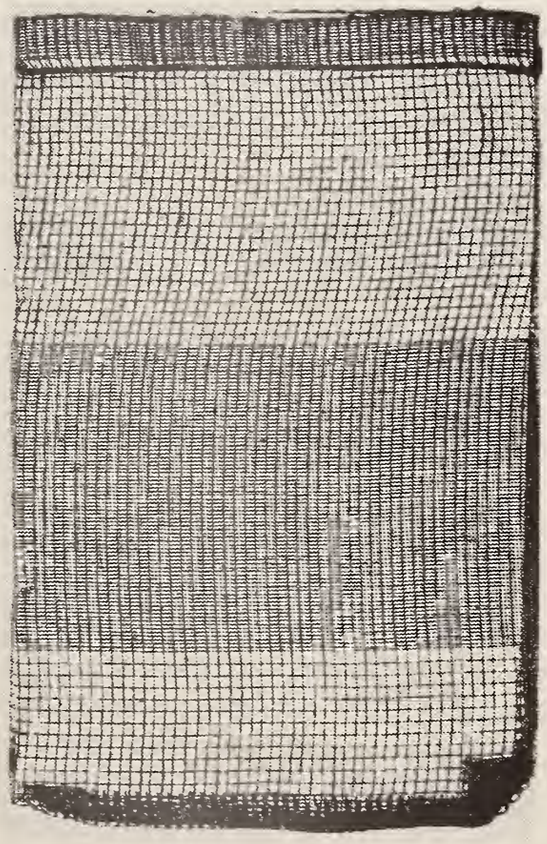
Photograph 71



Photograph courtesy of Division of Cotton Marketing, Bureau of Agricultural Economics, United States Department of Agriculture

Duplex cotton fabric, open-mesh and close-mesh woven in one piece, (photograph 71), about two sevenths actual size.

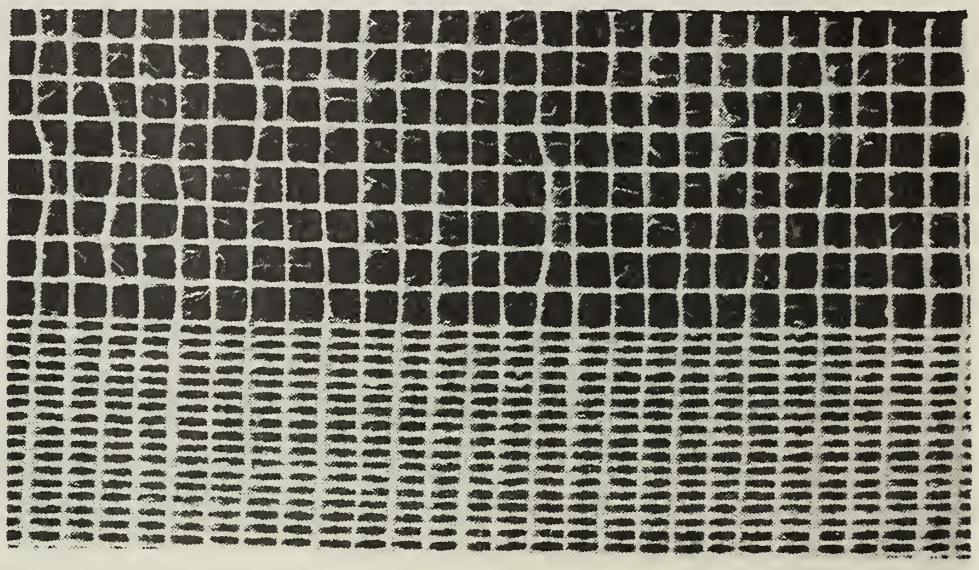
Photograph 72



Photograph by Marketing Section,
Agricultural Adjustment Administration,
United States Department of Agriculture

New type duplex cotton bag developed for use in packaging peanuts, about three sevenths actual size, (photograph 72).

Photograph 73



Photograph by Marketing Section, Agricultural Adjustment Administration, United States Department of Agriculture.

Actual scale photograph of type of fabric from which peanut bags were made, (photograph 73). The bag is made from leno weave fabric containing 12 warp (2x6) and 7 filling threads per inch. A band is centered around the bag.

Minimum specifications for five-pound cotton bags for packaging shelled raw peanuts.

1. Bag requirements
    a. Cut size of cotton fabric from which bags are made: 14-3/4 inches by 17-1/2 inches
    b. Finished size of bags in accordance with following limitations as to seams:
        (1) Fabric is folded so as to form a bag with the warp threads running around the bag;
        (2) Breaking strength of seams equals or exceeds specified strength of the fabric;
        (3) No hem necessary. Selvage of fabric forms top of the bag;
        (4) Method of closing, either
            (a) Drawstring inserted next to selvage; or
            (b) One-half inch draw tape inserted or woven within the selvage.

2. Fabric requirements (finished material)
   a. Weave: The weave is leno so woven as to form not less than a 3-1/4 inch band in approximately the center of the fabric. The band has three times the number of ends per inch in the warp as in the body of the fabric.
   b. Construction:
      (1) Width of fabric: 14-3/4 inches
      (2) Thread count
         (a) Warp: 12 threads per inch (2x6) leno weave
         (b) Filling: 7 threads per inch
      (3) Selvage
         (a) If drawstring is used, selvages consist of 28 threads reeded three times as close as in the body of the cloth (leno weave).
         (b) If draw tape is used, selvages consist of 20 ends, space without ends of approximately 1/2 inch (for tape) and 10 ends, all reeded three times as close as in the body of the cloth (leno weave).
   c. Weight: Not less than 1.15 ounces per linear yard 14-3/4 inches wide, (including draw tape or drawstring).
   d. Breaking strength (grab method).
      (1) Warp: 15 pounds per inch
      (2) Filling: 15 pounds per inch
   e. Sizing: The material is starched to a degree of stiffness where the fabric remains open and flat.
   f. Dyeing: The material is dyed a light red color.
3. Tolerances:

   No minus tolerances but any over tolerances from the above minimum specifications are permitted.

Minimum specifications for two-pound cotton bags for packaging unshelled peanuts.

1. Bag requirements:

   a. Cut size of fabric from which bags are made 18-1/2 inches by 14-1/2 inches.
   b. Finished size of bags in accordance with following limitations as to seams:
      (1) Fabric is folded so as to form a bag with the warp threads running around the bag;
      (2) Breaking strength of seams equals or exceeds specified strength of the fabric;
      (3) No hem necessary. Selvage of fabric forms top of the bag;
      (4) A drawstring consisting of four strands of red yarn, and four strands of black yarn, soft twisted, is inserted in the selvage for closing the bag.

2. Fabric requirements:
   a. Weave is leno.
   b. Construction:
      (1) Width: 14-1/2 inches
      (2) Thread count:
         (a) Warp: 8 threads per inch (2x4) or 16 threads per inch (4x4).
         (b) Filling: 4 threads per inch.
      (3) Selvage consists of 18 ends (2x9) reeded 3 times as close as in the body of the cloth
   c. Weight: 1.28 ounces per linear yard 29 inches wide.
   d Breaking strength (grab method).
      (1) Warp: 10 pounds per inch.
      (2) Filling: 10 pounds per inch.
   e. Sizing: The material is starched to a degree of stiffness where the fabric remains open and flat.
   f. Dyeing: The material is dyed a light tan color.

3. Tolerances:
   No minus tolerances but any over tolerances from the above minimum specifications are permitted.

Cooperating agency

All cotton bags for use in packaging peanuts were supplied to the Extension Service, Virginia Polytechnic Institute for distribution at Suffolk, Virginia.

The following quantities of cotton bags were supplied:

Purpose	Bag capacity	Number of bags	Approximate square yards equivalent
Packaging unshelled peanuts	2	135,400	28,000
Packaging raw shelled peanuts	5	70,000	13,938
Total		205,400	41,938

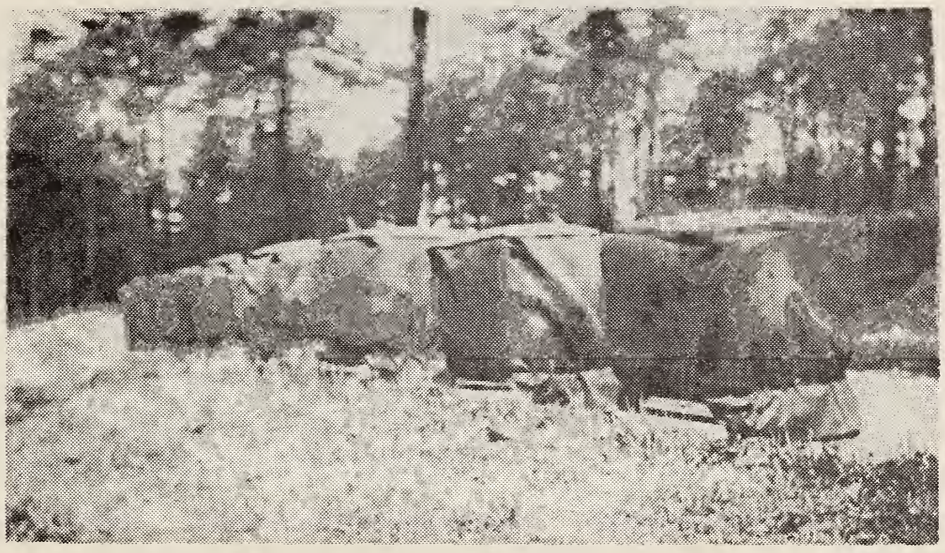
Cotton Covers For Colonies Or Hives Of Bees

The beekeepers in the United States lose at least one-tenth and frequently one-half and more of their colonies of bees every winter. Furthermore, many of the surviving colonies become greatly weakened through mortality caused by excessive heat production by the bees in their efforts to maintain proper heat conditions within the hive during cold winter weather.

It is believed possible to reduce colony mortality to less than one percent. To bring this reduction about, proper insulation of the hives is advocated in place of present make-shift arrangements.

By cooperation between the Division of Bee Culture of the United States Bureau of Entomology and Plant Quarantine and the Marketing Section of the Agricultural Adjustment Administration, there was recently developed a cotton bee hive cover which has prospects of proving very satisfactory. Results of trials conducted at the Government Apiary near Beltsville, Maryland, were so successful that the Bureau is now considering the establishment of projects in different areas which will use a total of about 2,500 covers.

Photograph 74-



Photograph by Marketing Section, A.A.A. U. S. Department of Agriculture

View showing bee hives protected from the winter weather with cotton pad insulation and covered with canvas waterproofed hoods. Heavy cotton twine is used to fasten the covers to the hives, (photograph 74).

The size of the finished pads measures 25 inches wide by 68 inches long. To construct the pad, an osnaburg material measuring 52 inches by 72 inches is used. This is stuffed with 2⅔ pounds of raw cotton. The hood, which is composed of cotton duck, measures 26 inches high by 25 inches deep by 21 inches wide. Waterproofing material was applied to the hood and to about 8 inches at both ends of each pad to prevent capillary action during rainy weather and thawing snows.

Photograph 75

Photograph by Marketing Section,
Agricultural Adjustment Administration
United States Department of Agriculture.

View of bee hive showing method of applying cotton insulation (photograph 75).

Photograph 76

Photograph by Marketing Section, Agricultural Adjustment Administration, United States Department of Agriculture.

Photograph 76 shows view of bee hive with cotton mats in place. Two insulation pads are required for each bee hive. Note that entrance to hive is left open.

AUTHORIZED PURPOSES

Data included in the foregoing parts of this bulletin cover only some of the uses for which cooperating agencies may try cotton under the provisions of the program now in effect.

The following indicates the purposes for which cotton and cotton products may be supplied by the Department of Agriculture to Federal, State, and other governmental agencies and to colleges, universities and non-profit organizations up to June 30, 1939:

1. As a covering or membrane either by itself or in conjunction with, or as reenforcing for, other materials, in connection with:

(a) irrigation, drainage, run-off or any other type of ditch, canal, or channel designed to carry or direct a constant or intermittent flow of water:

(b) levees, revetments, or any other construction for protection against flowing or moving water, or erosion;

(c) construction, maintenance or protection, temporary or permanent, of dams, reservoirs, and water storage facilities and controls, or the inlets thereto, or the outlets therefrom;

(d) fills or cuts for roads or highways, or in connection with other fills or cuts;

(e) seeding or reseeding, or preventing erosion of lawns, terraces, or in connection with the improvement or cultivation of land areas; and

(f) surfacing airport runways, roads, bridges, paths, walks, or in connection with the similar surfacing of other areas.

2. As wind barriers, wind breaks, or in any other manner in connection with the control or direction of blowing or air-borne soil or sand.

3. As a protection either as a covering or otherwise for fruits, vegetables, or other agricultural or horticultural products during growing, ripening, harvesting, curing, packing, storing, or other processes.

4. As a covering or otherwise for shading or protecting tree seedlings, shrubs, trees, vegetables, plants, flowers, vines, or other agricultural or horticultural products or growths, where not now customarily and commercially so used.

5. As a portable or permanent covering, hood or tent in connection with fumigating, spraying or dusting fruits, vegetables. vines, trees, plants, or other agricultural or horticultural products or growths.

6. As a covering or other part of cages or enclosures, designed for the propagation of insect parasites or similar purposes.

7. As a covering, screen or otherwise to prevent the egress of insects or other pests which might cause infestations.

8. As a protective covering or apparatus to prevent or lessen the nuisance caused by congregation of various species of winged wild life.

9. As a protection for colonies or hives of bees.

10. As a roof or outside covering material, as insulation, or as any other part of houses, cabins, cottages, outbuildings, or other permanent or semi-permanent structures, incuding buildings of a sectional or other type, which may be taken apart and reused from season to season, from time to time, or from location to location.

11. As a covering or pattern for bales of cotton, bales of hops, or other agricultural or horticultural products.

12. As a package, bag, container, covering, or baling, or other protection or wrapping, either by itself, or in conjunction with other materials, for wool, nuts, grains, fruits, vegetables, seeds, or other agricultural or horticultural products, during or after clipping, harvesting, gathering, curing, packaging, storing, transporting, merchandising, or during any other phase of marketing, preparing, or transporting such commodities, where not now customarily and commercially so used.

13. As a covering or protection for fleece (wool or mohair) before clipping.

14. As a covering or otherwise to check or eradicate undesirable weeds, grasses, or other undesirable agricultural or horticultural growth.

15. As a material in the construction of traps, cages or containers for game and other birds, fowls or animals.

16. For such other purposes as the Secretary may specifically find will effectuate the purposes of Section 32.